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MEMOIRS OF THE GEOLOGICAL SURVEY

OF

ENGLAND AND WALES.

THE

G E O L O G Y

OF THE

CARBONIFEROUS LIMESTONE, YOREDALE ROCKS,
AND MILLSTONE GRIT

OF

NORTH DERBYSHIRE AND THE ADJOINING
PARTS OF YORKSHIRE.

(SHEETS 81 N.E., 81 S.E., 72 N.E., AND ADJOINING PARTS OF 88 S.E., 83 N.W., 82 S.W.
AND 71 N.W. OF THE MAP OF THE GEOLOGICAL SURVEY.)

BY

A. H. GREEN, M.A., F.G.S., C. LE NEVE FOSTER, B.A., D.Sc., F.G.S.,
AND J. R. DAKYNS, M.A.

APPENDIX AND LIST OF FOSSILS

BY

R. ETHERIDGE, F.R.S.E., F.G.S.,
PALAEONTOLOGIST TO THE GEOLOGICAL SURVEY OF GREAT BRITAIN.

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NOTICE.

THE district described in this Memoir was originally surveyed, chiefly by Professor John Phillips and Mr. Warrington Smyth, and on the south by Professor Ramsay, Mr. Howell, and Mr. Hull, and the maps were published, about 15 years ago. At that time the divisions of the strata that lie between the Carboniferous Limestone and the Coal Measures were less understood than they are at present, and in many cases it was only possible to draw approximate boundary lines between the different sub-formations, leaving the maps thus produced to be filled in by after comers. During the last few years, however, especial attention has been paid to these rocks in Lancashire and North Staffordshire by Mr. Edward Hull and Mr. Green. Subdivisions have been drawn, which seem to be nearly constant over the whole of the north-midland counties of England, and suitable horizons have been agreed upon for the artificial lines of division between the Lower Coal Measures and the Millstone Grit, and between the latter and the underlying Yoredale Rocks.* The utility of this work is obvious, for if the detailed structure of the Millstone Grit and Yoredale Rocks is ignored, a great number of faults would be omitted on the maps, which are not only of importance in a scientific point of view, but also help to throw much light on actual or probable faults that pass into the Coal Measure country.

In order also to make the old maps of the Survey fit in with those published more recently, the Director General, Sir Roderick Murchison, gave orders to re-survey such parts of the country as should be found necessary, or, in other words, to trace in on the maps those newly established subdivisions that could be followed into the re-surveyed ground, and also to correct such small inaccuracies as were unavoidable at the time of the former survey. For this end we have had to go over again

* See Memoirs of the Geological Survey on Maps 88 S.W., 81 N.W., and 81 S.W., and a paper in the Quarterly Journal of the Geological Society, on the Millstone Grit of North Staffordshire, vol. xx. p. 242.

thoroughly the whole of the Millstone Grit and the Yoredale Rocks, and of these two sub-formations we hope to be able to give a fairly complete account. The Mountain Limestone and the Coal Measures it was not necessary for our present purpose to examine in so great detail. It is to be hoped that both may some day have memoirs devoted entirely to themselves; but as time cannot be spared at present for such works, there is only given in this Memoir what notes have been made on the Carboniferous Limestone and Lower Coal Measures when the work made it necessary for the officers in charge of the revised survey to intrude on these formations. The above statement was necessary as an excuse for the absence of that more complete information which some readers might expect regarding the Carboniferous Limestone and the Coal Measures. The original survey was made when it was supposed that geological maps and sections afforded sufficient information both to the miner, the land owner, and the ordinary man of science, and before the practice of publishing explanatory Memoirs of minor areas had been introduced, and there is consequently in this Memoir no special description either of the Coal Measures or of the Carboniferous Limestone. Nevertheless it seemed worth while, while describing the Yoredale Rocks and the Millstone Grit, to add such notes as had been gathered with respect to the other formations of the district, even though in parts the utmost that has been done amounts to very little.

A. C. RAMSAY,
Director of the Geological Survey
of England.

PREFACE.

WE will here state the share of each of the authors of this Memoir in the mapping and description of the country, and acknowledge the assistance received during the progress of the work.

In 1864 the greater part of quarter sheet 81 N.E. was resurveyed by Messrs. Green and Foster, a small part in the south-east corner being the work of Mr. Dakyns, who joined them towards the end of the year.

In 1865 Mr. Dakyns carried on the work by Chatsworth and Ashover down to Crich, and also mapped the neighbourhood of Stanton; while Mr. Green took in hand the district between Stoney Middleton and Rowsley, and the Lower Carboniferous Rocks in 82 N.W., assisted in the case of the latter by Mr. J. C. Ward.

The work was delayed by matters of more pressing importance during 1866, but in the early part of 1867 Mr. Dakyns completed the survey of the Millstone Grit from the neighbourhood of Crich southwards, and Mr. Green examined the country between Belper and Ashbourne, and the greater part of the Limestone boundary.

Each author describes in the Memoir the portions of the country surveyed by himself, with the exception of Dr. C. Le Neve Foster, who left the Survey at the beginning of 1865. The copious notes and illustrations, however, which our former colleague left behind him have been largely made use of, and entitle him to the right of a place on the title page. The general arrangement of the Memoir was entrusted to Mr. Green.

It has not happened that we have had to apply for information and assistance in many cases, but we have great pleasure in mentioning that, wherever this has been the case, we have met with the utmost readiness to comply with our request.

Mr. R. H. Ashton of Castleton, Mr. B. Bagshaw of Foolow, and Mr. Maltby of Eyam, gave us access to the mining plans in their offices; and Mr. W. C. Moore of Bamford, and Mr. E. W. Wass of Matlock, allowed us to visit their mines. We have also to thank for information, embodied in the following pages, and unless from unintentional oversight acknowledged in each case in the place where it occurs, the following gentlemen: Mr. Cottingham, agent to the Duke of Devonshire; Mr. J. Allport, general

manager, and Mr. W. H. Barlow, engineer, to the Midland Railway Company; Mr. E. W. Binney of Manchester, and Mr. Wardle of Leek, both old friends of the Survey; Mr. Sorby, and Mr. Mitchell Withers, of Sheffield; Mr. John Ward of Longton; and Mr. Young and Mr. Taylor of Oughtibridge. We believe this completes the list; but if there are any whose names have slipped from our memory, we beg leave to assure them with every apology that the omission is accidental, and hope that for this and all other shortcomings in the work we shall be dealt with as leniently as possible.

Geological Survey Office,
28 Jermyn St., London, S.W., 1868.

CONTENTS.

CHAPTER I.—INTRODUCTORY.

	Page
General description, physical features, geological structure, and drainage of the district - - - - -	1

CHAPTER II.—TABLE AND LITHOLOGICAL DESCRIPTION OF THE GEOLOGICAL FORMATIONS.

Carboniferous or Mountain Limestone - - - - -	5
Yoredale Rocks - - - - -	5
Millstone Grit - - - - -	7
Lower Coal-measures or Ganister-beds - - - - -	10

CHAPTER III.—DETAILED DESCRIPTION OF THE GEOLOGICAL STRUCTURE OF THE DISTRICT.

General sketch of the geology of North Derbyshire and adjoining parts of Staffordshire, Cheshire, and Yorkshire - - - - -	12
Detailed description under the following heads:—	
(1.) The main mass of the Carboniferous or Mountain Limestone - - - - -	18
(2.) The plateau of Yoredale Grit to the north of the main mass of the Limestone - - - - -	39
(3.) The outcrops of the Kinder Scout Grit on the west and north - - - - -	52
(4.) The neighbourhood of Bradfield north-east of the Agden valley - - - - -	56
(5.) The country between the Agden valley on the north, Derwent Edge on the west, the Rivelin valley on the south, and a fault through Dungworth on the east - - - - -	59
(6.) The Rivelin valley - - - - -	67
(7.) The country bounded by the Rivelin valley on the north, a line through Hathersage and Fox House on the south-west, and the Coal-measures on the east - - - - -	72
(8.) The country between Hathersage and Stoney Middleton, from Abney Moor on the west to the Derwent valley on the east - - - - -	84
(9.) The country between Stoney Middleton and Rowsley, from the Mountain Limestone on the west to the Derwent on the east - - - - -	87
(10.) Stanton Moor and its neighbourhood - - - - -	89
(11.) The Millstone Grit, Yoredale Rocks, and Mountain Limestone on the east of the Derwent, from Hathersage Moor on the north to Ambergate on the south - - - - -	91
(12.) The country south of the Mountain Limestone and north of the New Red Sandstone, from Ashbourne on the west to the Derbyshire Coal-field on the east - - - - -	110
(13.) Notes on the strip of Lower Coal-measures from Oughtibridge on the north to Dore on the south - - - - -	115

CHAPTER IV.—POST-PLIOCENE AND RECENT DEPOSITS.		Page
<i>Boulder-beds.</i> —General description and distribution	- -	127
Drift on the west and south of the Penine Chain	-	129
Drift in the valleys of the Wye and Derwent	-	130
Drift on the east of the Penine Chain	- -	132
General conclusions	- . - -	133
Elephant bones at Waterhouses	- - - -	134
River-deposits	- - - .	135
Clay and gravels of the Weaver Hills	- - - -	136
Flint implement	- - - -	137

CHAPTER V.—MISCELLANEOUS.		
Mountain Limestone	- - - -	137
Yoredale Rocks	- - - -	138
Millstone Grit	- - - -	140
Joints and Current-bedding	- - - -	143
Contrast between the lie of the rocks on opposite sides of the Penine anticlinal	- - - -	146
Rivers, valleys, and hills	- - - -	147
Landslips	- - - -	149

APPENDIX.		
On the fossils of the Carboniferous Limestone of Derbyshire	- -	151
INDEX	- - - -	159

LIST OF ILLUSTRATIONS.

COPPER-PLATE ENGRAVINGS.

- Plate I.—Sections from the central mass of Carboniferous Limestone, across the Yoredale Rocks and Millstone Grit to the Lower Coal-measures (to face p. 150).
- Plate II.—Section of the Carboniferous Limestone along the Midland Railway between Buxton and Monsal Dale (to face p. 20).
- Plate III.—Map to show the distribution of the Drift on opposite sides of the southern part of the Penine Chain (to face p. 134).
-

WOODCUTS.

Frontispiece. Weathered Millstone Grit on the Peak.	Page
Fig. 1. Section to show the outline of a shale and gritstone country -	3
2. Section near Buxton - - - - -	20
3. Section of the "vein" in the Blue John Mine, Castleton -	21
4. Plan of mines on Tideswell Moor - - - - -	23
5. Section across the lode at Great Hucklow - - - - -	25
6. Section across the lode at the Mill Close Mine, Winstler -	27
7. Diagram of a part of the valley of the Derwent, Matlock -	30
8. Comparative sections of the Derbyshire Carboniferous Limestone	32
9. Faulted boundary of the Limestone at Crowdecote - - -	34
10. Ditto ditto at Ludwell - - - - -	35
11. Section at Apes Tor, near Ecton - - - - -	37
12. Sketch of Fairbrook Clough - - - - -	41
13. Section in the Yoredale Grit, on the north side of The Peak -	43
14. Section of fault in Williams Clough - - - - -	46
15. Sketch of Alport Tower - - - - -	47
16. Contorted beds in the R. Derwent - - - - -	49
17. Section across Mam Tor and Edale - - - - -	50
18. Fault in Sallow Clough - - - - -	52
19. Section in Yoredale beds below the northern escarpment of the Kinder Scout Grit - - - - -	55
20. Section across the Bradfield Basin - - - - -	57
21. Comparative sections of the beds between the Rough Rock and Third Grit, in the neighbourhood of Bradfield - - -	65
22. Section across the Rivelin valley - - - - -	69
23. Diagram to show the thinning away of the Lower Kinder Scout Grit on Bamford Edge - - - - -	75
24. Fault at Mitchell Field, Hathersage - - - - -	76
25. Section across Rood Hill - - - - -	83
26. Section at Leam, near Hathersage - - - - -	85
27. Section across the valley of the Derwent near Chatsworth -	89
28. Section across Harthill and Stanton Moors - - - - -	90
29. Diagram to show the change of throw in a fault - - -	94

	Page
30. Section along Wood Brook, near Darley - - -	104
31. Sketch of quarry on Crich Hill - - -	108
32. Section of faults at Standlow near Kniveton - - -	112
33. Plan and section to show the lie of the toadstone near Kniveton	113
34. Section across the Lower Coal-measures of Stannington and Loxley - - - - -	117
35. Irregular bedding near Oughtibridge - - -	119
36. Sketch of quarry at Waterhouses - - -	135
37. Comparative sections of Millstone Grit and Yoredale Rocks -	139
38. Map to show the variations in the Third Grit - - -	141
39 & 40. Map and diagram of the joints in the Third Grit of Stanage Edge - - - - -	144

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GEOLOGY OF THE COUNTRY DESCRIBED IN THIS
MEMOIR.*

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and The Peak in Derbyshire. Fol.
Oxford.
- 17—, Anon. - - - History of the Mineral Waters of Buxton,
and other Warm Waters in The Peak of
Derbyshire, with a discourse on Petrifying
Springs and the Malton Chalybeate. 4to.
1776. J. J. Ferber - - - Versuch einer Oryctographie von Derby-
shire.
1784. G. Pearson - - - Observations and Experiments for investi-
gating the Chemical History of the
Tepid Springs of Buxton, &c.

Sketches of a History of the Atmosphere
of The Peak, and of the Form and
Structure of the Mountainous Region of
Derbyshire. London.
1789. R. Watson, D.D. - - - Chemical Essays. (Derbyshire Lead Ore,
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1789. J. Pilkington - - - A view of the present state of Derbyshire.
8vo.
1798. C. Hatchet - - - Observations on Bituminous Substances,
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Trans. Linnæan Society, vol. iv. p. 129.
1799. B. Faujas de Saint-Fond - - - Travels in England, Scotland, and the
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Mémoire sur le Caoutchouc, ou Bitume
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Mus., i. 261.
1802. John Mawe - - - The Mineralogy of Derbyshire, with a
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Phil. Mag., vol. xxxix. p. 81.
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the consideration of the Board of Agri-
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Account of the great Derbyshire Denuda-
tion. Philosophical Trans. for 1811.

On the Stratification of Matlock in Derby-
shire. Phil. Mag., vol. xxi. p. 36.
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* For a great part of this list, which does not pretend to be exhaustive, we are indebted to our colleague, Mr. W. Whitaker.

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1834. W. Hopkins - - - On the Stratification of the Limestone District of Derbyshire. Printed for private circulation.
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- Rev. W. Thorp - - On the Diluvial and Gravel Beds of Yorkshire and Nottinghamshire. *Geol. and Polytec. Soc. of the West Riding of Yorkshire*, vol. iii. p. 244.
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1866. Edwin Brown - - On the Drifts of the Weaver Hills. *Report of British Association*. 1866.
- G. Maw - - - On the Clays and Sands subjacent to the Boulder Clay. *Geol. Mag.* vol. iv. p. 241, 299; *Quart. Journ. of Geol. Soc. of London*, vol. xxiii. p. 387.
1867. R. D. Darbshire - - Notes on some supposed Deposits at Great Orme's Head, and on Pholas Holes at high levels near Buxton. *Mems. of the Lit. and Phil. Soc. of Manchester*, 3rd series, vol. iv.

PUBLICATIONS OF THE GEOLOGICAL SURVEY, REFERRED TO IN THIS MEMOIR.

Sheets 88, S.E.; 81, 82, N.W.; 82, S.W.; 72, N.W.; 72, N.E.; and 71, N.W. of the *Geological one-inch Map of England*.

Six-inch Maps of Yorkshire 281, 287, 288, 293, 294.

Horizontal Sections, Sheets 18, 41, 42, 57, 60, 65, 69, and 70, with explanatory pamphlets, and sheet 55.

Memoir on the Geology of the country round Stockport, Macclesfield, Congleton, and Leek.

Memoir on the Iron Ores of Great Britain, Part IV.

G E O L O G Y

OF THE

CARBONIFEROUS LIMESTONE, YOREDALE ROCKS, AND MILLSTONE GRIT

OF

NORTH DERBYSHIRE AND PARTS OF YORKSHIRE.

CHAPTER I.

INTRODUCTION.

IN a Memoir on the Quarter Sheets 81 N.W. and 81 S.W. of the Map of the Geological Survey of Great Britain,* an account was given of the geology of a tract of Lower Carboniferous Rocks, lying on the west of the central axis of northern England, and bounded on the north by a line through Manchester and Staleybridge, and on the south by the New Red Sandstone plain of the centre of England. In the present Memoir we propose to attempt a like task for the corresponding beds on the eastern side of the axis.

The district to be described takes in the wild moorlands and the grassy limestone slopes of the High Peak of Derbyshire, the uplands on the borders of that county and the West Riding of Yorkshire, and a long narrow strip of country running down the valley of the Derwent, through Chatsworth, Matlock, and Ambergate, towards Belper. It lies in Sheet 81 N.E., and parts of Sheets 88 S.E., 82 N.W., 82 S.W., 81 S.E., 72 N.E., and 71 N.W. of the Geological Survey Map of England.

On the west are Glossop, a large manufacturing town, Chapel-en-le-Frith, and Buxton; in the centre, the villages of Castleton, Hope, and Hathersage; on the east we stop a little short of Sheffield, and the chief market towns are Bakewell, Winster, Wirksworth, and Belper.

GENERAL DESCRIPTION AND PHYSICAL FEATURES OF THE COUNTRY.

The main physical features of the country are so closely connected with its geological structure that a sketch of the one cannot be given without some reference to the other, and we must therefore endeavour to combine the two. Looking at the country as a whole, we may trace one great anticlinal axis, ranging a little west of north, through North Derbyshire and the West Riding of Yorkshire, the southern portion, in

* "The Geology of the Country round Stockport, Macclesfield, Congleton, and Leek." Memoirs of the Geological Survey.

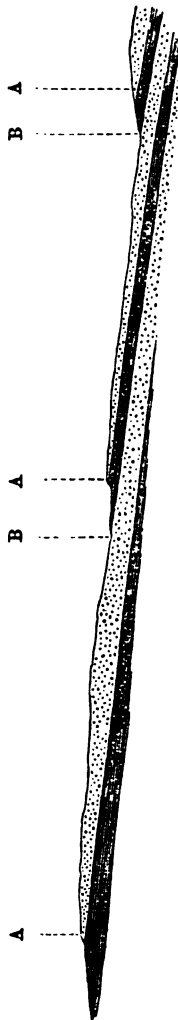
fact, of the great central or Penine anticlinal or "backbone" of the north of England. It throws off on the one side, with a steep westerly dip, the Coal Measures of Lancashire and North Staffordshire, and on the other the great Coal-field of Yorkshire and Derbyshire, the dip in this direction being much more gentle. The upheaval has been greatest in the north of Derbyshire, where a large dome-shaped mass of Mountain Limestone has been brought to the surface, from which the beds slope away, gently to the north, with a very sensible dip to the east, and still more rapidly to the west; so that while in the first direction we may go far before we reach any formation higher than the lowest beds of the Millstone Grit, a short journey either to the east or west enables us to cross the whole of the Yoredale Rocks and Millstone Group, and reach the overlying Coal Measures. The highest points of the Limestone country are about 1,500 feet above the sea, while the Millstone Grit ridges run up to 1,800, and in a few cases 2,000 feet; this is perhaps partly due to the fact that chemical and mechanical action have both had a share in the wearing away of the limestone, while the latter alone has been the main cause of the removal of the grits. The outlines of the Limestone country are for the most part smooth and gently rounded, not very much unlike those of the chalk downs, though, owing to the greater hardness of the rock, they have not the almost voluptuous softness of the latter. Some such likeness is only to be looked for, for in each case we have a thick mass of nearly pure limestone, liable to the same atmospheric influences, chemical and mechanical. This somewhat tame and uninteresting country is channelled by deep dales or ravines, some of which are of great beauty, specially where the stream has worked its way through the thickly bedded part of the formation, and has eaten out a narrow road bounded on either side by steep and in some cases vertical cliffs, often crowned by woods, drooping shrubs, and ivy, the bright colouring and graceful outline of which contrast strongly with the cold grey tone and stern massiveness of the rock.* That these dales were originally underground watercourses, the roof of which has been worn through by atmospheric agency, was suggested by Professor Phillips, and the idea has been worked out by Mr. Boyd Dawkins for the valleys and caverns of the Mendip Hills.† As instances of these deep valleys we may mention Miller's Dale and Chee Tor in the valley of the Wye; the valley of the Derwent at Matlock and Cromford; and Dovedale. In the less massive parts of the formation the valleys are broader and not so rugged; Monsal Dale, in the valley of the Wye, is a good example. The features just described seem to be the result of river and atmospheric action upon a thick mass of nearly *homogeneous* limestone; but when we pass to the surrounding country of Yoredale Rocks and Millstone Grit, where hard massive sandstones are interstratified with thick beds of softer shale, we find that the same causes have produced vastly different features in the scenery. Here the outcrop of each grit bed forms a long, unbroken ridge, sloping gently in the direction of the dip, and often at nearly the same angle, and ending on the other side in a sharp cliff or "edge," below which is a broad valley hollowed out in the underlying beds of

* The impression made by these dales on our ancestors will be gathered from the following description of Dovedale written about a century ago. "Proceeding, therefore, towards the edge of the plain, they came to a precipice of an astonishing height, from which was a stupendous view into a deep valley, the hills rising on the opposite side, covered with wood, nearly half a mile perpendicularly."—The Spiritual Quixote, Book X., Chap. VII.

† On the Caverns of Burrington Combe. By Messrs. W. A. Sanford and W. B. Dawkins.

softer shale. The stream at the bottom of this valley will often be found to run along the top of the grit bed next below, which slopes up and forms the other side of the valley, ending in its turn in a cliff on the next hill top, beyond which there will be another steep-sided valley. The section below, which is drawn from nature, on a true scale, will explain this.

Fig. 1.
Section showing the General Outline of the Grit Country.



The sandstone beds are shown by dotting, and each forms a little cliff or bank at the top of each ridge, as at A ; the steep hill side below is formed of shale, and at the bottom of the valley we have a brook at B running on the top of the grit next below. To this general type all the main ridges and the valleys between them conform more or less closely, though it would not be easy to find many sections which satisfy it as fully as the one just given.*

We may here mention that these well-marked features are a great help in the geological mapping of the country. The base lines of the several gritstone beds are so clearly given by the sharp edges just mentioned, that they may often from some commanding height be sketched in for miles round. And it has been our usual custom to trace them in first of all in this way, and then walk along each line separately, correcting any errors in our first rough determination by the help of what evidence there may be on the spot. The small brooks, which run down the flanks of the escarpment into the main longitudinal valleys just described, are very useful in this way. At the base of each gritstone there is mostly a cliff over which the water falls in a little cascade into a deep pool below. The moisture and spray are ever wearing away the shale at the base of the cliff, and masses of sandstone from time to time lose their support and tumble over, and the valley is thus gradually worked farther and farther back into the hill, and a clean section always shown of the junction of the grit and shale. The upper boundaries of the gritstones are by no means so clearly marked. Here, however, the shape of the ground is often a good guide, for the upper surface of the sandstone often forms a long gentle slope, over which the

shales come on in low hummocks rising after a while into a steeper bank. When these natural features are indistinct we look to the changes in the nature of the ground, from the dry sandstone soil to the cold wet land of the shales ; or to the herbage, rushes being found in the shale, and heath and furze growing more plentifully on the sandstone ; and here we may specially notice the little *viola lutea*, a

* See p. 62.

crowded belt of which, perhaps not many yards broad, is often seen along the outcrop of a sandstone bed, while not a single plant will be found on the shales which come out on either side. *Viola palustris* in the same way sticks to the shales, but it is too rare to be of any use as a geological guide. If all these helps fail us we recollect that each upper boundary runs between two consecutive base lines; and as the latter can be mostly fixed with great accuracy, the amount of error in the determination of the former can never be very large.

Drainage.—Nearly the whole of our district lies on the east side of the great watershed of central England, the line of which ranges over Combs Moss, along Rushup Edge and Cowbarn, and a little to the east of Kinder Scout, the westerly flank of the Peak; thence it runs northwards till it meets the ridge formed by the northern outcrop of the Millstone Grit, which it follows for about four miles, when it strikes away northwards into country with which at present we have no concern.

The brooks to the west of this line flow into the Goyt or Etherow, and so find their way into the Mersey.

The streams rising on the east of the central watershed flow either into the Derwent, the Don, or the Dove, and so in the end their waters are carried into the Humber.

The Derwent rises in the moorlands on the borders of Derbyshire and Yorkshire and forms for some distance the boundary between these countries; its course is a little east of south, and it falls into the Trent below Derby.

The chief feeders of the Derwent in the northern part of its course are the small rivers Alport, Ashop, and Noe. The first two join at Alport Bridge and fall into the Derwent at Ashopton. The last flows along the vale of Edale and joins the main stream at Mytham Bridge. We might perhaps say with more truth that here the waters of four streams are gathered into one channel and form the Derwent, for above this point the river which bears that name has little claim to be regarded before the others as the main stream. Lower down the Derwent receives the Wye, which rises near Buxton, at Rowsley; and the Amber at Ambergate.

The Dove rises on Axe Edge and flows past Ashbourne into the Trent near Burton.

The only feeders of the Don with which we shall have to deal are the Agden, Bradfield, Rivelin, Ewden, and Porter brooks: the first two join to make the little river Loxley, which receives the Rivelin brook and falls into the Don a little above Sheffield. A little lower down the Don receives the waters of the Porter brook and the little river Sheaf; and while the town has doubtless borrowed its name from the latter, the confluence of so many streams has determined its position. Even in the present days of steam their banks are thickly lined with mills and grinding "hulls;" and, when water was the only available source of power, a district so richly gifted was sure to become a busy centre of manufacture.

CHAPTER II.

TABLE AND LITHOLOGICAL DESCRIPTION OF THE GEOLOGICAL FORMATIONS.

The rocks we shall have to describe belong, with the exception of Recent and Glacial deposits, to the Carboniferous system. The following table shows them in descending order :

Recent.	Alluvium and River-gravels.
Post-Pliocene.	Boulder Beds.
Carboniferous Rocks.	Lower Coal Measures or Ganister Beds.
	Millstone Grit.
	Yoredale Rocks.
	Carboniferous or Mountain Limestone.

Carboniferous or Mountain Limestone.—This is a mass of limestone of very great but unknown thickness. Very thin partings of shale or clay are found in it here and there, and two or more beds of contemporaneous igneous rock called Toadstone.

In the upper portion the limestones are thinly bedded and somewhat earthy, and contain layers and nodules of chert. Below the cherty group comes a great thickness of exceedingly massive pure limestones, at times semi-crystalline, of white or pale grey colour ; and underneath these there is a mixture of thickly and thinly bedded limestones.

The Toadstone, which seems to be a truly interbedded rock, varies from a soft crumbly ash to a hard closely grained greenstone ; as far as our imperfect knowledge goes, however, we should say that its most usual form is an ash or ashy-looking rock. The number of the toadstone beds is still uncertain. In a pamphlet, printed for private circulation in 1834, the late Mr. W. Hopkins, the well-known mathematician, endeavoured with great ingenuity to explain all the facts bearing on the matter he could collect, on the hypothesis of there being only one toadstone ; he does not seem to have been aware that two and perhaps three beds of toadstone have been sunk through in the same shaft ; but besides this he was obliged to call in to his aid faults, many of which have certainly no existence. White Watson, in his “Delineation of the Strata of Derbyshire” (1811), gives three beds of toadstone, and this was also Farey’s view ; see also Conybeare and Phillips’ *Outlines of the Geology of England and Wales*, p. 448.

There seems reason to believe that in places there are three beds, but that they are liable to thin away, as indeed is only likely ; but we cannot surely say, till the Limestone country has been more thoroughly examined, how many toadstones there are, and whether any or all of them spread uniformly over the whole district ; for instance, it would be very rash to assume that the highest toadstone of Matlock and the highest toadstone of the neighbourhood of Buxton belong to one and the same bed.

Yoredale Beds.—Under this head we include a mass of sandstones, shales, and limestones lying between the Mountain Limestone and the Lowest Millstone Grit. On the western side of the great anticlinal

these beds were best shown in the neighbourhood of Leek, and we there subdivided them as follows.*

Subdivisions of the Yoredale Rocks.

- | | | |
|--|---|--|
| 1. Upper Group. | { | 1a. Shales.
1b. Yoredale or Shale Grit.
1c. Shales, with perhaps a few thin beds of limestone. |
| 2. Middle group.
Yoredale Sandstones. | { | Sandstones, hard and closely grained, here and there semi-crystalline quartz-rocks, with partings and thick beds of black shale. |
| 3. Lowest Group. | { | Black shales, with thin beds and nodules of earthy limestone. |

The highest and lowest groups of the above threefold division are found in the country we are now describing; it is somewhat doubtful whether the middle group is represented.

The shales 1a immediately below the Kinder Scout or Lowest Millstone Grit have thin sandstones, and rarely thin beds of coarse grit in them.† They vary in thickness from 30 to 300 feet. These beds are mostly found cropping out along a steep hill side below the craggy escarpment of the Kinder Scout Millstone Grit.

The Yoredale or Shale Grit‡ reaches in the country round the Peak a thickness of 500 or 600 feet; though it thins away to the south, and in places dies out perhaps altogether, we get what seem to be traces of this bed even down to Duffield. In the north it is made up of thick massive sandstones, here and there passing into coarse grits and even conglomerates, with many layers and a few thick masses of interbedded shale. When these shale beds are traced across the country they are found sooner or later to die away, and fresh shale bands set in on a slightly different horizon; hence we have not been able to make out any subdivisions of this complex mass that would be lasting, and the whole has been mapped and coloured as a single subdivision.

The country occupied by this rock round The Peak is a broad plateau some 500 feet lower than the table of The Peak itself, deeply channelled by rivers and brook courses. The hills are heavy and flat-topped, with rounded edges and gently curving flanks, and along the steep sides of the valleys run little terraces marking the outcrops of the shale bands. These physical features enable us at a glance to distinguish between the Yoredale Grit and the Kinder Scout beds, the outcrops of the latter forming very generally bold craggy cliffs, often crowned with piles of rocks weathered into fantastic shapes.

The existence of the beds marked 1c was very doubtful about Leek, and we have not been able to recognize them on this side of the axis.

* The Geology of the Country round Stockport, Macclesfield, Leek, and Congleton (Mems. of Geol. Survey,) p. 17.

† See pp. 43 and 44.

‡ In the Memoir on the neighbourhood of Leek, &c., we discarded the very appropriate name of "Shale Grit," given to this rock by Farey, White Watson, and the older geologists, under the impression that it was an abbreviation of "Limestone Shale Grit," and as we adopted the name Yoredale Rocks in the place of the older term Limestone Shale, for uniformity's sake we changed "Limestone Shale Grit" into "Yoredale Grit." A fuller acquaintance with the rock has shown us that the old name had reference to the thick beds of shale which are interstratified with the sandstones of the Shale Grit. "This stone I call the Shale Freestone, or Shale Grit, from the circumstance of its always alternating with shale." (Farey, General View of the Agriculture and Minerals of Derbyshire, vol. 1, p. 228). Farey's name, moreover, being derived from a local peculiarity, is unsuited for a general classification.

On the western side of the anticlinal the Yoredale Sandstones form the most striking member of the group, and are believed to reach in places the great thickness of 2,000 feet, but even there they were found to be very changeable, and sometimes had not more than a tenth of that thickness. On the eastern side their possible representatives, though they nowhere reach so great a thickness as on the western, are just as changeable. In the Edale valley they vary from 200 to 400 feet, and about Bamford are still thicker, but they are often wanting altogether, and we have not been able to trace them southwards farther than Hathersage. Though the sandstones are for the most part hard and finely grained, we nowhere find on this side of the axis those peculiar quartz-rocks which are characteristic of this group about Leek and Macclesfield. Indeed, but for the sake of comparison with other sections, it is doubtful whether in the present country these beds deserve to be classed as a separate group; for in them the sandstones, which formed the bulk of the Yoredale Grit, become gradually thinner and fewer in number, while the shale bands swell out and form the mass of the rock, and thus the supposed representatives of the Yoredale Sandstones are in reality passage beds between the Yoredale Grit and the Third Division of the Yoredale beds, the bulk of which consists of black shale. The great irregularity in the thickness of this group, and the fact that it is at times wanting altogether, leads one to suspect that here, if anywhere, an unconformity may be looked for among the Lower Carboniferous Rocks, but as yet we have no evidence of anything of the sort. But it must not be forgotten that cases may occur where it would be impossible to separate the Yoredale Sandstones from the Yoredale Grit; both of them are masses of sandstone and shale, but in the latter there is much more sandstone than shale, and in the former more shale than sandstone; now if the sandstones in the former were to thicken out so as to overpower the shales, which is neither unlikely nor impossible, there would be nothing to enable us to distinguish between the two, and they would both be classed and mapped as Yoredale Grit, and this may be the true explanation of the apparent absence in places of the Middle Group of the Yoredale Beds. We may also here mention that both the upper and lower boundary lines of the Yoredale Grit, though they show in a general way where sandstone ends and shale comes on, are often far from true geological horizons, for these sandstone beds never keep for long the same thickness, but are wedge-shaped, dovetailing into the shales, so that thick masses of sandstone often are lost altogether, and their place taken by shale within a very small distance. Cases of this will be given in detail farther on.

The Lowest Group needs little description. Its upper part is almost wholly black shale, among which are a few nodules of earthy limestone with *Goniatites*: lower down, beds of black earthy limestone, which seem to become purer and more plentiful towards the bottom, are interstratified with the shales. It is not possible to form any very trustworthy estimate of the thickness of this division in the north of our district. Between Castleton and the Peak the beds roll so much that it is not safe to trust to an average dip, but it cannot there be well less than 400 or 500 feet, and may be as much as 1,000 feet thick. In the Lady Wash Mine, near Eyam, the thickness of this group was proved to be 340 feet.

Millstone Grit.—The classification adopted by the Geological Survey places under this head the group of beds shown in descending order in the following table.

Subdivisions of the Millstone Grit.

1. First Grit. The "Rough Rock" of Lancashire.
2. Shales.
3. Thin Coal here and there.
4. Second Grit. The Haslingden Flags of Lancashire.
5. Shales and Sandstones. } The "Brookbottom
6. Coal, very generally, but not always, present. } Series" of Lancashire.
7. Third Grit.
8. Shales and Sandstones.
9. Coals, mostly very thin, here and there.
10. Fourth and Fifth, or Kinder Scout Grita.

The first six of these subdivisions are placed in the Lower Coal Measures by some authors, who call our Third and Fourth Grits the First and Second Millstones. The great Carboniferous System is, as far as we know, conformable and without break from top to bottom,* and it would be idle therefore to argue that one method of subdivision was better than another, since all alike must be artificial and merely matters of convenience.

The Kinder Scout Grit consists in the north of Derbyshire of two thick beds of massive gritstone and conglomerate, parted by a thick mass of shale. As we follow this subdivision southwards we find that the lower gritstone dies away on Bamford Edge: the upper bed runs on, but becomes step by step thinner and more finely grained down to Chatsworth: hence southwards it gradually recovers itself, and about Rowsley, Matlock, and Ashover is again a very striking sandstone, by no means, however, so coarse and massive as the rock we started with in the north, except perhaps about Birchover. The features made in the landscape by the escarpments of these grits have already been mentioned.

On the top of the Upper Kinder Scout Grit, and sometimes on the top also of the Lower, are traces of very thin seams of coal. They are of no economical value, but have an important bearing on the question of the changes that went on during the formation of the Grit Series.

The beds between the Kinder Scout and Third Grits are mostly shale, but sandstones are found in them, one especially being often seen near the top of the division.

The Third Grit is a rock very changeable in mineral character. About the centre of the district we are now concerned with it has, under its typical form, the upper and larger part red, massive, and coarse, often a conglomerate, while the lower beds are finely grained, flaggy sandstones. It is seen under this form at Crow Chine. The under flagstone is, however, often wanting, and the rock coarse grit from top to bottom. The bed keeps this character pretty uniformly from Crow Chine to the south of Chatsworth, and along all this range it is further distinguished by its very marked and regular jointing. It is owing to this peculiarity in its structure that the Third Grit forms those escarpments often running for miles in an unbroken wall of rock which are the most noticeable features in the scenery of the Grit country; for as the shales beneath are undermined by the action of the weather, huge rectangular masses of the gritstone will break off along joints, and the face

* Though something may be said in favour of a break at the base of the Middle Coal Measures, the evidence for it is as yet very meagre. See *Geology of the country round Bolton-le-Moors* (Memoirs of the Geol. Survey), p. 7. In referring to this passage I must beg to be allowed to correct a slight mistake in it. I never saw the section there described.—A. H. G.

of the cliff will thus be from time to time renewed and so kept sharp and clean. Thus it happens that we may easily pick out, even from a distance, the escarpments of the Third Grit by the regular, wall-like face of their cliffs, and distinguish them from the wild and weird looking basset edges of the Kinder Scout bed.

Towards the south the Third Grit becomes finer, and passes into a firm, closely grained sandstone, mostly of a reddish colour.

Northwards this bed changes very rapidly. The upper coarse part disappears, or only shows here and there, while the mass of the rock is finely grained sandstone, sometimes massive and well jointed, sometimes splitting into flags. When we come to follow this rock further north, beyond the country described in the present memoir, we shall find that this variation is only the prelude to still wider changes.

A coal, No. 6, is very frequently found on the top of this bed; it varies from a foot to five feet in thickness, and is of poor quality. It is, however, worked for engine fires or brick burning, and in out-of-the-way parts is sometimes used as a house coal.

We have for the sake of uniformity adopted the classification used in former Memoirs of the Geological Survey, and spoken of a Second Grit. There is, however, in the present country no single bed of sandstone we can point to occupying a definite horizon, and sufficiently well marked and persistent to deserve that name. The measures between the Rough Rock and Third Grit are from their changeable and wayward character a sore trial to the field geologist. They are made up of shales, sandstones very irregular in their thickness and horizontal range, and here and there beds of ganister and thin coals. Thus between Hollow Meadows and Bradfield we find at one spot only a single sandstone 25 feet thick among these beds: a mile or two further two well-marked sandstones parted by shale are seen, the three together reaching a thickness of 200 feet: still further on there are three or four thin beds of sandstone lying in a mass of shale, and then again a number of sandstones thick enough to form a striking mass of rock.* And we are sure, in spite of these changes, that the beds are throughout on the same horizon, because the Rough Rock can be traced above them, and the Third Grit below them for the whole distance. These sudden changes may perhaps be rather startling to the cabinet geologist. They will, however, be no cause for wonder to the field worker, who sees daily like dovetailings and interlacings of shales and sandstones on a smaller scale in quarries and natural sections. Our method of dealing with these beds has been to trace out and colour as Second Grit, any sandstones lying between the Rough Rock and Third Grit that were thick enough and sufficiently well marked to allow of their being laid down with accuracy.

The First Grit, or Rough Rock, though very changeable in thickness, varying from 25 to 100 feet, keeps, with a few exceptions, pretty much the same character everywhere. It is coarse and massive, and here and there a conglomerate, often red in colour and mostly contains a large proportion of felspar, the decomposition of which makes the rock loose and crumbly. Here and there, however, this bed loses entirely its peculiar stamp and passes into a finely grained flagstone, but before long we always find it coming back to its typical form.

On the top of the Rough Rock there lies, here and there, a valuable bed of fireclay, largely worked about Crawshaw. This seems to be the equivalent of the Featheredge Coal, which on the western side of the anticlinal holds the same place in the series.

* See pp. 62-64.

A general view then of the Millstone Group shows us five thick sandstones or grits parted by shales having thinner sandstones interbedded with them. On the top of each of the great sandstones there are traces, more or less, of coal; also the upper surface of each is in many cases seen to have been furrowed and waterworn before the overlying shale was deposited upon it; and we may often in a brook course compare on a newly bared surface of grit the furrows and hollows which were thus formed ages ago, with the like channels and pot holes which the stream is now eating out in the same rock.

The grit beds must have been formed in a shallow sea, and the above facts make it likely that during the formation of each the sea-bottom was slowly rising, till at last the top of the sandstone was brought above water, and furnished a land surface for the growth of coal, over which small streams flowed and ate out shallow channels. The whole seems afterwards to have been sunk deep below the waters, into which finely divided mud was carried and settled down gently, forming a mass of thinly bedded shale. And when this had gone on for some time the bottom would again begin to rise, and when the water became shallow enough another grit bed would begin to be laid down.*

Lower Coal Measures or Ganister Beds.—Under this head we place the beds lying between the Silkstone, Sheffield, or Black Shale Coal, and the top of the Rough Rock.

The group is made up of a number of thick sandstone beds parted by shales; a few thin coals; and several fire clays, of great economical value, and largely worked to supply the Sheffield steel works with fire bricks and crucibles.

The sandstones are very changeable both in thickness and character, as will be seen when we come to the detailed description of the country occupied by these beds. The coals are thin, poor, and very uncertain; they have often ganister floors, specially in the case of the bed known as the Ganister Coal, beneath which we almost always find more or less ganister of very good quality: in the case of the other coals the ganister, when present, is seldom so good, and is much more irregular in its occurrence. The ganister was till lately chiefly used as road metal; but it was found that the scrapings of the roads mended with it served admirably to puddle up any cracks in the Sheffield furnaces, and the rock itself is now largely ground down for the same purpose, and for coating the inside of the furnaces: it is laid on in a soft state and baked by the heat into a good fire-resisting lining. It is also used, mixed with pounded fire bricks, in the Bessemer process of steel making for lining the inside of the "converters."†

Both coals and fire clays are very often, but not always, found on the top of a sandstone bed.

The following section of the beds below the Silkstone Coal between Ecclesfield and the neighbourhood of Oughtibridge will give a good general notion of a part of this group; but both the thicknesses and number of the beds vary very much from place to place.

* On the subject of the formation of the gritstones, see Mr. Sorby's most ingenious and valuable papers, *Edinburgh New Philosophical Journal*, new series, vol. iii. p. 112; iv. p. 317; v. p. 275; vii. p. 226; *Reports of the British Association*, 1856, p. 77; *Geological and Polytechnic Society of Yorkshire*, vol. iii. p. 232; p. 372; p. 669.

† See Percy's *Metallurgy of Iron and Steel*, p. 821.

General Section of the Lower Coal Measures between Ecclesfield and Oughtibridge.

	ft.	in.		ft.	in.
Coal.—Upper Silkstone: worked	3	0	Shales, with an irregular sandstone bed	200	0
White bind	18	0	Sandstone, with a band of shale and bed (about three feet thick) of inferior ganister and fire clay	40	0
Coal.—Lower Silkstone: not worked	2	0	Shale, with ironstone	200	0
Sandstones, with interbedded shales containing ironstone, and three thin coals	190	0	Sandstone	50	0
Coal.—Whinmoor	2	0	Shale	100	0
Shale, sometimes with Ganister	15	0	Coal.—Ganister coal	2	0
Sandstone, with beds of sandy shale	50	0	Ganister and fire clay	4	0
Clayey shale, with ironstone	25	0	Shale, with ironstone	30	0
Coal	0	9	Bastard ganister	9	0
Fireclay	3	0	Coal	0	6
Black and clayey shales, with ironstone	110	0	Clay	2	0
Coal.—Charlton Brook	1	0	Bind	6	0
Underclay	3	0	Sandstone	24	0
Shale	7	0	Shale	42	0
Sandstone, with a shale band	130	0	Coal	0	9
Shale	40	0	Fire clay	2	0
Grenoside sandstone	80	0	Sandstone	35	0
Shale	100	0	Shale	75	0
Green Moor sandstone, with thin beds of sandy shale *	35	0	Coal	2	0
			Fire clay	6	0
			Sandstone	45	0
			Shale	60	0
			Fire clay	7	0
			Sandstone	40	0
			Shale	30	0
			Sandstone	35	0

The thicknesses are taken on the average of a number of sections, and are, of course, only approximations.

* This bed is much thicker on Green Moor.

From the above account it will be seen how closely the Millstone Grit and the Lower Coal Measures are like one another in their lithological character. Each is a group of thick sandstones parted by shales, and in each beds of coal are very generally found on the top of the sandstones. The differences are these. Among the Millstones the sandstones are thicker, fewer, further apart, more constant both in size and character, and as a rule coarse grits or conglomerates. The Lower Coal Measure sandstones are none of them so thick as the thickest Millstone; there are more of them; they are parted by narrower bands of shale; are very changeable, often passing quickly from finely grained flagstones to coarse massive grits; but as a rule they are not so coarse as the Millstone Beds. Also in the Lower Coal Measures coal beds begin to come in among the shales between the sandstone beds. Moreover, as far as our present knowledge goes, the Millstone Grit and the Lower Coal Measures are closely related palæontologically.

All the evidence, therefore, goes to show that in the country now under consideration the Lower Coal Measures, Millstone Grit, and perhaps the Yoredale Rocks, form together one natural subdivision of the Carboniferous System; and that the mineral character alone of the Mountain Limestone entitles it to the place of a lower subdivision. The lithological stamp and fossils of the Middle and Upper Coal Measures are perhaps marked enough to lead us to place them together

in a separate upper group; especially if the unconformity suspected between the Middle and Lower Coal Measures should be shown to be of more than local occurrence.

We now see how it is that different horizons have been taken by different authors for the boundary line between the Millstone Grit and the Lower Coal Measures, for since the two are so much alike that no division exists in nature, personal fancy or local convenience will determine in each case a different artificial line of separation.

CHAPTER III.*

DETAILED DESCRIPTION OF THE GEOLOGICAL STRUCTURE OF THE COUNTRY.

Having given in the last chapter an account of the general lithological character of each of the formations, we may pass to details, and describe the position which the rocks now occupy at the surface, and the local lithological changes which are found in them.

It will be convenient first of all to take a general view of the whole of North Derbyshire, and the adjoining parts of Staffordshire, Cheshire, and Yorkshire, and to note the lie of the beds, and their relationship to one another on each side of the great central arch of the Penine Chain.

On the west we shall notice only such general facts as are necessary to show the connexion between the rocks on opposite sides of the saddle, and for details refer the reader to the Survey Memoir already published on that district; † on the east we shall first give a general sketch of the geological structure, and afterwards dividing the country into a number of districts, describe under the account of each such lesser details as call for special regard.

Taking our stand then on the Mountain Limestone we note that its beds dip away in every direction from the centre of the mass, and pass out of sight on all sides beneath the Yoredale Rocks; these latter are overlaid by the Millstone Grit, but the belt of them, which parts the Limestone from the Grits, varies very much in breadth from place to place according to the angle of the dip, rolls, and contortions, and repetition of the beds by faults; the Millstone Grit is in turn covered up by the Lower Coal-measures, and the breadth of country which it covers varies from the same causes. The distance, however, along any east and west line from the crest of the anticlinal arch to the lower boundary of the Coal-measures is pretty nearly the same on both sides of the axis, for though the westerly or Staffordshire- and Lancashire-dip is as a rule much steeper than the easterly or Derbyshire- and Yorkshire-dip, the foldings and repetitions of the beds are much more numerous on the first side than on the second, and these two opposing causes have very nearly balanced one another.

We start at the Weaver Hills, the south-western corner of the Penine tableland, and skirting the limestone along its western, northern, eastern, and southern boundaries in turn, by Hartington, Buxton, Castleton, Bakewell, Winster, Wirksworth, and Ashbourn, note how,

* In this and the next chapter the parts treating of the main outlines and general geological structure of the country are printed in the ordinary type used throughout the work; while lesser details and matters of local occurrence are printed in a smaller type.

† The Geology of the Country round Stockport, Macclesfield, Congleton, and Leek (Memoirs of the Geological Survey of England and Wales).

as we look out in each direction, we find the overlying rocks coming on, sometimes in regular order with a steady and uniform dip, so that the whole of the Millstone Grit and Yoredale groups may be crossed and the Lower Coal-measures reached in the space of a few miles; but oftener with many a fold, arch, and fault, by which the lower beds are again and again brought in, at times to such an extent that we may reach the line where the New Red Sandstone covers up the Carboniferous Rocks, without having passed over any beds higher than the lowest division of the Yoredale Rocks. We shall refer in our description to the following sections in the order below.

Horizontal Section of the Geological Survey	-	Sheet 57, No. 2.
Do.	-	Sheet 57, No. 1.
Do.	-	Sheet 41.
Do.	-	Sheet 42.
Section No. 1, Plate I. of the present Memoir.		
Horizontal Section of the Geological Survey	-	Sheet 18 (Western part).
Do.	-	Sheet 70 (Western part).
Do.	-	Sheet 69 (Western part).
Do.	-	Sheet 55, No. 2.
Section No. 2, Plate I. of the present Memoir.		
Horizontal Section of the Geological Survey	-	Sheet 69 (Eastern part).
Section No. 3, Plate I. of the present Memoir.		
Horizontal Section of the Geological Survey	-	Sheet 70 (Eastern part).
Do.	-	Sheet 18 (Eastern part).
Section No. 4, Plate I. of the present Memoir.		
Section No. 5, Plate I. of the present Memoir.		
Horizontal Section of the Geological Survey	-	Sheet 60.
Sections Nos. 6 and 7, Plate I. of the present Memoir.		

The Weaver Hills and the high ground between them and Caldon are formed of some of the lower, thickly bedded portions of the Carboniferous Limestone, and are bounded by a series of faults, which bring these beds directly against Yoredale Rocks, throwing out entirely the upper, thinly bedded and cherty limestones (see sect. 2, sheet 57). Beyond Caldon, however, these latter rocks are found passing regularly beneath the black shales of the lowest division of the Yoredale Rocks, and the boundary, though broken by faults, and here and there formed by a fault, is upon the whole a natural one till within a couple of miles south of Hartington (see sect. 1, sheet 57, sheets 41 and 42). From this point up to a spot a mile and a half west of Buxton, we again find the limestone bounded by a succession of faults, which, as at the Weaver Hills, bring its lower thickly bedded parts directly against the Yoredale Rocks (see Sect. 1, Plate 1).

West of the boundary just marked out, the beds though bent into many folds and broken by faults have a general dip to the west (see sections, sheets 41 and 42), till we reach the axis of a long synclinal, ranging north and south by Mottram, New Mills, Whaley Bridge, and Leek, to Cheshire, to which Farey gave the name of the Goyt Trough.

Along this line the beds begin to turn up to the west, and continue to rise in that direction till we reach a long line of fault, also ranging north and south by Marple, Disley, Jenkin Chapel, Forest Chapel, down to Wetley Rocks, which has been named "The Anticlinal Fault" (see sect., sheet 18). Crossing this fault we mostly find a reversal of the dip, whence the name, and to the south of Macclesfield enter on a belt of very contorted ground, where the rocks are again and again bent sharply into troughs and saddles, the most notable among which are the Rudyerd basin, which ranges through Rudyerd and Horton down

to the little coal-field of Wetley and Shafferlong, and the anticlinal ridges of Bosley Minn and Biddulph Moor. Beyond this broken country we come to the well-marked basin of the coal-field of The Potteries (see sections, sheets 42 and No. 1, 55). North of Macclesfield the anticlinal character of the great fault just mentioned comes out more strongly than over the country south of that town; the dip on the western side of it is steadily to the west, and the country is occupied mainly by a long strip of coal-measures, the southerly limb of the Lancashire coal-field, fringed here and there with an edging of Millstone Grit. About Hyde and Poynton the middle measures, containing thick workable coals, come on (see sections, No. 2 sheet 55, and sheet 69).

Lastly the Carboniferous Rocks are bounded on the west by a line of fault, known as the "Red Rock Fault," which ranges by Stockport, Macclesfield, and Congleton, and brings in on its eastern side various members of the Permian and Triassic formations. The change in scenery, from the wild and rugged uplands of the Carboniferous Rocks on the east of this fault to the tame and undulating plain which stretches from it far away to the west, is sharp and very striking, and would alone give the line of disturbance to a close degree of accuracy.

A strip of the country just described, ranging from Caldon Low up towards Macclesfield, is, with the exception of the Rudyerd Basin, three outliers of Bunter Conglomerate, and an inlier of Carboniferous Limestone at Mixon, wholly occupied by Yoredale Rocks. The lowest group, consisting of black shales and limestones, forms a valley or marshy plain immediately to the west of the main mass of the Limestone. The Yoredale Grit is here wanting, and the black shales are overlaid by the Yoredale Sandstones, which are believed to reach the great thickness of 2,000 feet, and which in a succession of troughs and arches spread over nearly the whole of the rest of this belt, and play the most important part in its geology. Among the escarpments formed by these sandstones the most notable are Sharpcliff and Morridge, while the folds into which they have been thrown have given rise to the long narrow ridges of Gun Hill, Bosley Minn, and Biddulph Moor, which owe in great measure their marked outline to the steep saddle-shaped lie and the hardness of the rocks of which they are made up.

On the south side of this strip of Yoredale Rocks the Millstone Grit comes on in a narrow belt, which skirts the northern edge of the Cheadle Coal-field, winds round the Rudyerd basin, and bounds on the east and north-west the great Coal-field of The Potteries. The Grit series is here reduced by the southerly thinning away of the beds to three members, the Rough Rock, Third Grit, and a band of shale between them; and the thickness of the whole is only from 300 to 400 feet. For further details, and for an account of the North Staffordshire Coal-fields, the reader is referred to the Memoir already quoted.

If we now return to the Limestone to the north of Hartington, and look out west and north-west, we shall find a country showing far greater variety than the belt just described (see sections, Plate 1, fig. 1 of the present Memoir, fig. 18 of the Memoir already quoted, and sheet 18). Sheen Hill first strikes the eye, an outlier containing the three lowest sandstones of the Millstone Grit group: we also find that the Yoredale Grit has here set in; its escarpment makes a bold ridge to the west of the main mass of the Limestone up to Longnor, and to the north-west of that town the rock is found in broad spreads capping the hill-tops for the distance of about three miles; below the Yoredale Grit the Yoredale Sandstones come out again, owing to the fall of the ground and an easterly dip; they are well seen in Lady Edge and Ravage Top. Then follows a belt of contorted ground, lying between two faults which have been called

the Easterly and Westerly Mixon faults, and occupied mainly by the lowest Yoredale beds. Beyond this a steady dip to the west sets in, and after crossing the Yoredale Sandstones and Grit we reach a four-fold line of escarpments formed by the eastern basset of the Millstone Grits of the Goyt Trough; of these the one formed by the Third Grit is by far the most marked and persistent. About three miles to the north-east of Leek we cross the axis of the trough, and the grit escarpments wind round, and with the change of dip run north-west till they abut against the anticlinal fault. It would be hard to find anywhere a more marked synclinal symmetry than is shown by the beds of the Goyt Trough between this neighbourhood and Whaley Bridge.

We will now return to the Limestone at Buxton. The boundary between that town and Doveholes is a natural one broken by cross faults. Immediately to the west the ground rises into the large flat-topped hill of Combs Moss, which is capped by an outlier of Third Grit, while round its flanks the outcrops of the Fourth, Fifth, and Yoredale Grits run in concentric rings (see section, sheet 70). This ground is bounded on the west by a large down-throw fault, beyond which lies the symmetrical basin of the Goyt Trough; to the west of this is the anticlinal fault, ranging down the Saltersford valley, by which the beds are again thrown in with a reversed dip, so that we have on the west of the valley a set of escarpments facing and corresponding to those formed on its eastern flank by the westerly basset of the rocks of the Goyt Trough. By a continuation of the westerly dip the Lower Coal-measures are brought in, and worked, at Bollington, Rainow, and Macclesfield.

Returning to the Mountain Limestone at Doveholes we find that from thence all the way round, almost as far as Wirksworth, its boundary is a natural one, with a few exceptions which will be treated of when we come to details; we also notice that from Doveholes by Castleton to Eyam the limestone is fringed by a belt of low-lying ground, often of inconsiderable breadth, formed of the bottom Yoredale shales; that from this low land the ground rises steeply along a slope which is roughly parallel to the Limestone boundary, and runs up to a height of 700 feet or so above the shale plain. Climbing this slope we find it to be the edge of a table-land, nearly 60 square miles in area, formed of the Yoredale Grit (see section No. 2, plate 1). We may mention that the Yoredale Sandstones are hereabouts wanting, or so feebly represented, as to form no feature worth notice in a general sketch. The northern part of the Yoredale Grit plateau, though deeply cut into by the gorges of the Ashop, Alport, and upper part of the Derwent, with their tributary brooks, still retains enough general flatness of surface to deserve the name we have given it; on the south, however, the denudation of Edale and of the broad part of the Derwent valley between Bamford and Hathersage, has carried away so much of the Yoredale Grit that it would be more correct to say that the geological structure of the country shows that it must once have formed part of the plateau to the north, but that it consists now in the main of outliers parted by broad valleys of denudation from the mass of rock to which they were once joined. In this sense we shall say that the southern boundary of this table land of Yoredale Grit runs along Rushup Edge, by Lord's Seat, the flanks of Lose and Win hills, Bradwell Edge, Hucklow Edge, down to the east of Eyam.

In the centre of this table-land, just on the crest of the great saddle, is a large outlier of the lowest Millstone bed, forming the flat-topped hill called the Peak, some points on which are nearly 2,000 feet above the sea. Smaller outliers of the same grit are found on Brown Edge, Crook Hill, and Win Hill.

If we neglect small rolls and disturbances, we may say that the rocks over this central plateau lie in a broad basin, of so flat a shape that the beds throughout may be looked upon as horizontal. But on the west the Yoredale Grit bends sharply over, and is soon carried out of sight, and the lowest Millstone Grit comes on along the eastern basset of the Goyt Trough, and forms a ridge from Chapel-en-le-Frith through Hayfield to Glossop. This range forms the boundary on the west of the country we are more immediately concerned with in the present memoir; the district beyond has been already described in the memoir on maps 81 N.W. and S.W.* On the north a fine range of the same grit rises in rocky cliffs from the plateau of Yoredale Grit, and stretches eastward from Glossop for about nine miles; this will be our limit on the north. To the east, again, the beds slope gently away, the Millstone Grits come on along Derwent and Bamford Edges, and range southwards through Matlock down to Belper, forming a belt between the central mass of Mountain Limestone and Yoredale beds on the one side, and the Coal-field of Yorkshire and Derbyshire on the other.

To this easterly belt of Millstone Grit we may now turn our attention. From the neighbourhood of Bradfield to Fox House, near Hathersage, the dip of the beds, never very great, lessens as we go east, and the Millstone Grits lie in three basins, cut off on the east by a succession of faults which bring in the Lower Coal-measures. The village of Bradfield stands on the southern edge of the most northerly of these, which we will call the Bradfield basin; it is triangular in shape, and cut off so sharply on all sides by faults, that with the exception of the Rough Rock on Kirk Edge, the outcrops of the rocks are prevented from showing that tendency to wind round, which is characteristic of a basin-shaped lie.

South of this is what we will call the Crawshaw basin, in the centre of which lies an outlier of Lower Coal-measures on Ughill Moor. It is cut off on the east by a fault through Dungworth. (See section, sheet 69).

The Rivelin valley parts the Crawshaw basin from a broad spread of Millstone Grit, in which a general dip towards the middle prevails, and which we will call the Rood Hill basin. The highest bed is an outlier of Rough Rock on Rood Hill. This basin is cut off on the east by a fault through Fulwood Chapel. (See section No. 3, Plate 1).

From Fox House southwards to Rowsley we find a more steady easterly dip than over the area last described, and the different members of the Yoredale and Millstone Grit groups come on in regular order, and are at last covered up by Lower Coal-measures at a distance varying from three to six miles from the eastern boundary of the Carboniferous Limestone. (See section, sheets 70 and 18).

South of Rowsley there is on the west of the Derwent valley a bay in the Limestone, in which stand some very noticeable outliers of Kinder Scout Grit on Stanton and Harthill Moors. (See section, fig. 28). On the other side of the Derwent valley there is for a while a steady dip to the east, and we cross in going up the slope the outcrops of the several members in order, up to the Third Grit. The beds, however, soon begin to flatten, and the last-named rock forms in consequence a broad plateau over Beeley, Darley, and Tansley moors. Further east the beds turn up in that direction, and the whole series down to the Carboniferous Limestone is again brought

* The Geology of the Country round Stockport, Macclesfield, Congleton, and Leek (Mems. of the Geol. Survey).

out to day along the western flank of the Ashover valley. Along this valley an anticlinal ranges, on crossing which the dip is reversed, and the rocks again slope away to the east, passing at some spots by a natural junction beneath the Lower Coal-measures of the Derbyshire coal-field, but for the greater part of the way being brought against the latter by a down throw fault through Trinity Chapel (see sections No. 4 and 5, pl. 1). The regular run of the measures is broken through near Crich by two upcast faults, between which a dome-shaped mass of Carboniferous Limestone has been upheaved (see section sheet 60, and No. 6, plate 1); but south of this we again find a broad spread of Kinder Scout grit, capped by outliers of the Third bed, and dipping gently to the east. This tract reaches from the Black Rock near Cromford down to Morley, and is cut off on the east by a fault through Ambergate, which brings in on the far side Lower Coal-measures; (see east end of section, No. 7, plate 1).

It now remains to notice the country south of the main mass of Carboniferous Limestone. The boundary of the latter from Wirksworth to the Weaver Hills is partly natural and partly formed by faults. South of it is a broad spread of the lowest Yoredale shales and limestones, covering the country up to the edge of the New Red Sandstone plain of central England. The sameness of this tract is a little broken by an inlier of Carboniferous Limestone near Bradbourn, and an outlier of Yoredale Grit around Kirk Ireton; (see section No. 7, pl. 1).

We now pass to the more detailed description of the geology, and will take in hand one by one each of the following districts into which the country may be handily divided.

- (1.) The main mass of the Mountain Limestone.
 - (2.) The plateau of Yoredale Grit to the north of the main mass of Limestone.
 - (3.) The lines of outcrop of the Kinder Scout Grit on the west and north.
 - (4.) The neighbourhood of Bradfield lying north-east of the Agden valley; (the Bradfield basin).
 - (5.) The country lying between the Agden valley on the north, Derwent Edge on the west, the Rivelin valley on the south, and a fault through Dungworth on the east; (the Crawshaw basin).
 - (6.) The Rivelin valley.
 - (7.) The country bounded by the Rivelin valley on the north, a line through Hathersage and Fox House on the south-west, and the Coal-measure boundary on the east; (the Rood Hill basin).
 - (8.) The country between Hathersage and Stoney Middleton, from Abney Moor on the west to the valley of the Derwent on the east.
 - (9.) The country between Stoney Middleton and Rowsley, between the Mountain Limestone on the west and the Derwent on the east.
 - (10.) Stanton Moor and its neighbourhood.
 - (11.) The Millstone Grit, Yoredale Rocks, and Mountain Limestone on the east of the Derwent valley, from Hathersage Moor on the north to Ambergate on the south.
 - (12.) The country south of the Mountain Limestone and north of the New Red Sandstone, from Ashbourn on the west to the Derbyshire Coal-field on the east.
 - (13.) Notes on the Lower Coal-measures from Oughtibridge on the north to Dore on the south.
-

(1.) *The Limestone District.*

It was not found necessary for the ends for which the country was resurveyed to examine the limestone district in detail, and we can therefore offer only a very imperfect account of it, but we propose to give here the few disjointed observations we have been able to make.

The best section of the limestone measures is given by the Midland Railway between Buxton and Monsal Dale: it has been measured and plotted to scale by help of a section of the railway kindly furnished by the Midland Company, and is engraved on Plate II.

We will first give an abstract of the beds shown, and then point out where each is best seen, and note anything of interest as we go along.

Section of the Mountain Limestone between Monsal Dale and Buxton, engraved on Plate II.

	Feet.
1. Thinly bedded limestone, somewhat earthy, with layers and nodules of chert, and thin shale partings in the lower beds	250
2. Thickly bedded limestone - - - - -	50
3. Thinly bedded limestone and chert - - - - -	90
4. Toadstone, perhaps in places as much as - - - - -	100
5. Massive white limestone, Miller's Dale rock, with perhaps a bed of toadstone in the middle, at least - - - - -	320
6. Toadstone, about - - - - -	20
7. Very thickly bedded, white limestone, Chee Tor rock - - - - -	500 to 600
8. Limestones, more or less concretionary, with shale partings - - - - -	150
9. Limestones, some thickly and some thinly bedded: of these there is seen about - - - - -	100
Total thickness shown without reaching the bottom - - - - -	1,580

The cutting at the east end of the Monsal Dale tunnel, where No. 1 rises, in a series of easy rolls, from beneath the Yoredale shales and earthy limestones, gives the following section:

Section showing the junction of the Yoredale Beds and Mountain-limestone at the east end of Monsal Dale Tunnel.

	ft.	in.
	{ Black shale.	
	{ Earthy limestone - - - - -	
	{ Black shale - - - - -	
	{ Limestone - - - - -	
	{ Black shale - - - - -	
	{ Calcareous black shale - - - - -	
	{ Black shale - - - - -	
	{ Earthy limestone - - - - -	
Yoredale	{ Black shale - - - - -	
Rocks.	{ Limestone - - - - -	
Lowest Group.	{ Black shale - - - - -	
	{ Limestone - - - - -	
	{ Black shale - - - - -	
	{ Limestone - - - - -	
	{ Black shale - - - - -	
	{ Limestone - - - - -	
	{ Black shale - - - - -	
	{ Earthy limestone - - - - -	
	{ Black shale - - - - -	
	{ Earthy limestone - - - - -	
	{ Black shale - - - - -	
Mountain	{ Thinly bedded limestones with chert, No. 1.	
Limestone.	{	

Crossing the river we find the same cherty beds as on the east of the tunnel, and below them like thinly bedded limestones with shale partings. There are

two very small faults, and near one of them the rock is very curiously veined with calc-spar; a little further on a lode crosses the line, its fissure is about 12 feet wide, filled in with calc-spar, among which is scattered a little galena; the crystals are mostly in prisms ranged at right angles to the walls, but in the middle there were some concretionary nodules.

From beneath these cherty beds rises a more thickly bedded limestone, No. 2, beneath which there are again about 90 feet of limestones and chert, No. 3.

At the west end of Cressbrook Tunnel a thickly bedded, white limestone, No. 5, comes out from beneath No. 3, and runs on through Litton Tunnel, to the west of which the beds dip down, and the cuttings are in beds belonging to No. 3, which are here fossil bearing, and have among them thin lenticular partings of shale and red clay.

No. 5, being carried down by the dip just mentioned below the level of the railway, forms a range of fine cliffs along the lower part of Miller's Dale, and may be traced along the steeply scarped sides of the valley, while beds belonging to No. 3 are shown in the cuttings above, till we come to Litton Mill. Opposite this mill, however, instead of Nos. 5 and 3 being in contact, as was the case at Cressbrook and Litton tunnels, they are parted by a thick mass of toadstone, the section given by the cuttings being:

- | | |
|----------------------|---|
| No. 3. | Thinly bedded limestones with chert; false bedding in the lower part. |
| No. 4.
Toadstone. | (1.) Soft crumbly yellow clay. |
| | (2.) Dark olive green, mottled, coarse ashy toadstone, amygdaloidal in parts; with large rounded lumps, finely grained, hard, and yellow, also amygdaloidal at times. |
| | (3.) Toadstone, dark olive green, and more solid. |
| | (4.) Do. shaly, with concretions. |
| | (5.) Hard, dark grey, finely grained toadstone. |
| | (6.) Toadstone, soft, concretionary, and vesicular. |
| | Thinly bedded limestone full of corals. |
| | Do. do. with shale bands. } A few feet thick. |

No. 5. Massive, white limestone.

We believed, though we could not feel sure, that each of the divisions of the toadstone was a true bed, with a gentle dip to the east; and in this case the whole will be about 100 feet thick. All the beds but (5) were very ashy, but that had the look of a truly melted rock. There was no sign of alteration in the underlying limestones at their junction with the toadstone.

It must be allowed that so rapid a thinning out of the toadstone as is required by the above explanation is somewhat startling. After a careful examination of the ground, however, we could come to no other conclusion, and as the rock seems more of an ash than a true lava, there is after all nothing so very strange in its coming sharply to an end.

We must here for a moment leave the railway, and note the section seen as we go down into the dale; it gives us

Toadstone. No. 4.

Massive white limestone. 150 feet about. Upper part of No. 5.

Toadstone.

Of the bottom bed we just see the top of a dome-shaped mass sticking out in the bottom of the dale.

Returning to the railway we find the massive white limestone, No. 5, lying all but flat or rolling gently, in all the cuttings up to the entrance of Chee Tor Tunnel. At the beginning of this cutting the beds rear up all at once at an angle of 40°, and at the mouth of the tunnel the dip has increased to 60°, and a bed of toadstone No. 6 breaks out. This will at first be of course taken to be the same as the bed already mentioned as peeping up in the bottom of Miller's Dale; but that bed lay only 150 feet below the top of No. 5, while in the cutting alone, which we are now looking at, there are 320 feet shown of solid limestone above No. 6 toadstone. Either, then, No. 5 has more than doubled

in thickness between here and Miller's Dale, or the Miller's Dale toadstone thins out to the west, and No. 6 is a distinct and lower bed. We think the latter supposition more likely.

It is very difficult to make out exactly how the toadstone No. 6 behaves on account of the disturbed state of the beds, but it seemed most likely that it flattens very suddenly and is the same bed as crops out a little before reaching the steep descent to Chee Tor: in this case its thickness will be between 10 and 20 feet.

The toadstone No. 6 rests on a mass of very thickly bedded, white limestone between 500 and 600 feet thick, No. 7. The magnificent precipice of Chee Tor gives a fine section of part of this rock. The cliff is said to be 300 feet high, and shows three beds of limestone, the lowest of which is most likely close upon 200 feet thick.

Below the Chee Tor rock are limestones by no means so thickly bedded; they are often split up by irregular shale partings into nodular masses; they are marked No. 8.

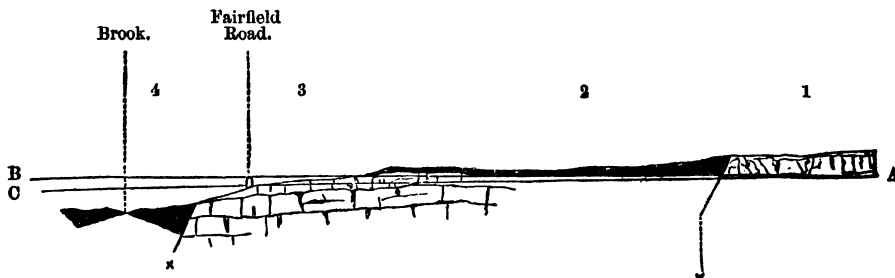
The beds marked No. 9 are the lowest shown in the section, and consist of a number of limestone beds of various thicknesses; they form a long flat dome reaching as far as the Pig Tor tunnel. A very odd rock was noticed at one spot, at first glance exactly like a sandstone, but on examination the grains were seen to be rhombohedrons of calc-spar loosely cemented together.

Along the long flat top of the saddle the beds roll a great deal, but at Pig Tor a steady dip sets in to the west; we cross the westerly outcrop of Nos. 8 and 7, and at the mouth of the tunnel nearest to Buxton find a toadstone, which agrees well with No. 6, resting on the top of the latter. The bed is about 20 feet thick, solid, rather concretionary, vesicular or amygdaloidal, dark olive green colour, but weathering red along the joints. The upper surface of the underlying limestone is very much waterworn.* For the most part there is no sign of alteration at the junction; but here and there the rock has a baked look for a depth of two or three inches.

The toadstone is again seen at the western mouth of the tunnel; it is here contorted and very much broken. It seems, however, to be overlaid by a massive white limestone, which agrees with No. 5, and which may be traced till about 250 yards before the bridge over the Fairfield road, where it begins to be much shattered, and about 50 yards farther on it is faulted against black Yoredale shales, as shown in the figure below.

Fig. 2.

Section in the Midland Railway east of Buxton.

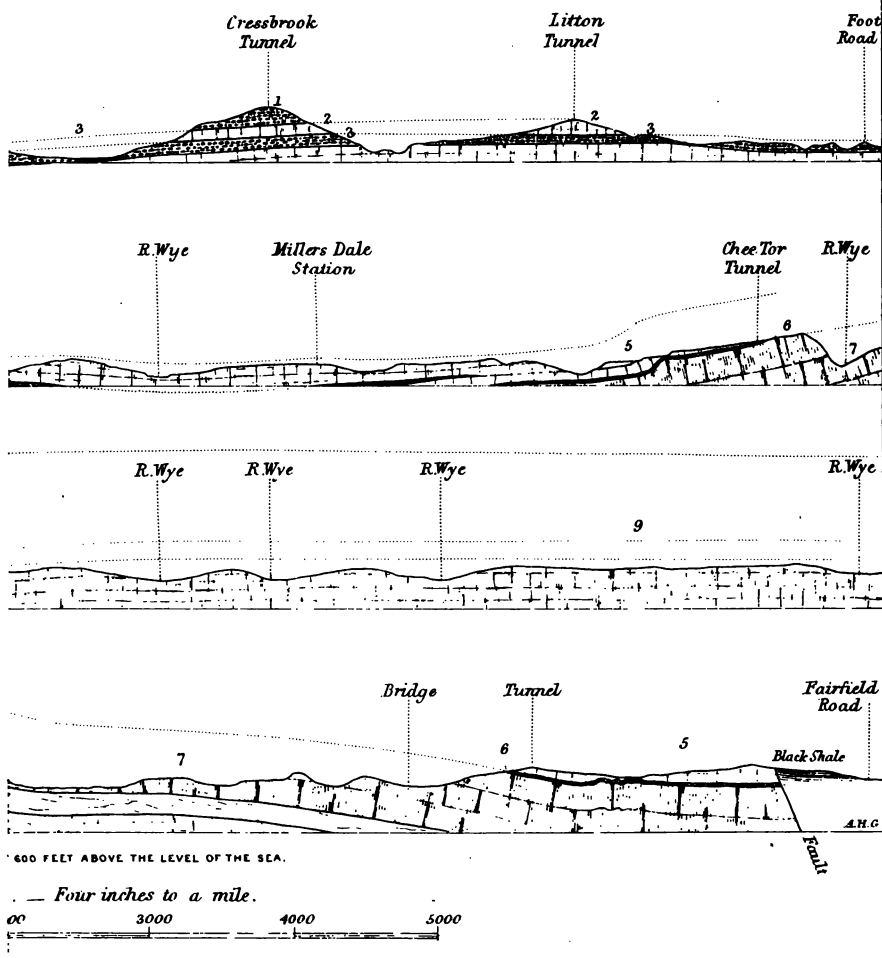


- | | | | |
|---|-----------------------|-----------------|--|
| 1. Thickly bedded limestone, much shattered near the fault. | | | |
| 2. Black shale. | 3. Limestone. | 4. Black shale. | |
| A C. Horizontal line. | A B. Line of railway. | x x Fault. | |

* This may be because the top of the limestone was a land surface before the toadstone was deposited; but it is quite as likely that the furrows and hollows on the surface of the limestone have been produced by acidulated water percolating through the porous toadstone, long after the formation of both limestone and toadstone.

Plate II

Along the Midland Railway, between Monsal Dale & Buxton.



Here, then, our section is broken off, but in the Doveholes brook we see the topmost cherty beds of the limestones passing regularly below the Yoredale shales. If our identifications are correct, it follows from this that there is some other fault yet undiscovered, or that the equivalents of Nos. 1, 2, and 3 are much thinner on this side the anticlinal than we found them to be on the east side.

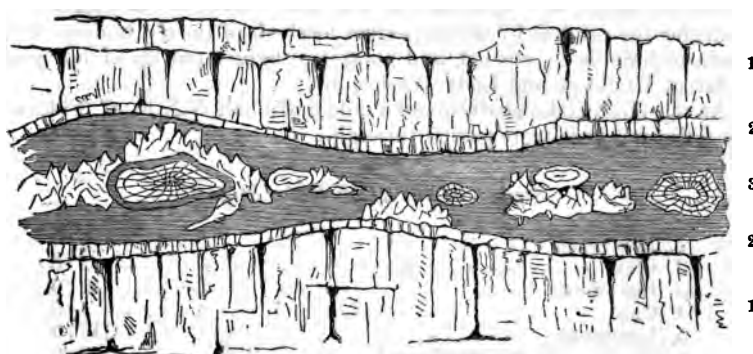
Castleton. Note on the Blue John Mine.

Blue John is a name given to a dark purple, concretionary variety of Fluor-spar, much valued for ornaments, and found, it is said, nowhere but in this mine.

Fig. 3 is a section of part of one of the so-called veins, which are very irregular, flattened pipes, running for a while almost horizontally, and then bending sharply up or down and cutting across the bedding. At the point where the section is taken "the vein" was nearly flat. Its upper and under surfaces are lined by coatings of blue Fluor, and the space between these is filled up by a mixture of reddish-brown clay, yellow, crystallized Fluor-spar, and nodular sulphate of baryta. In this are scattered here and there concretions of the Blue John, arranged in concentric layers of different tints, and radiated. Some of these concretions are coated with clay. Nodules of Blue John are also found in the solid limestone. The clay is not at all unlike the "clay-with-flints" found on the Chalk, and has very likely been formed in the same way.*

Fig. 3.

Section of "the vein" in the Blue John Mine.



1. Limestone. 2. Blue Fluor-spar.
3. Mixture of clay, yellow Fluor-spar, and sulphate of baryta, with nodules of Blue John.

The limestone near the vein was here and there very markedly bituminous.

In a quarry just north of the words "Windy Knoll" on the map there was a good deal of inferior blue Fluor-spar with bitumen, some of the latter of the elastic variety.

* See the Geology of Parts of Middlesex, &c. (Sheet 7). Memoirs of the Geol. Survey, p. 64.

Section at Doveholes.

					Feet.
1.	{ Limestone with chert Encrinital limestone Limestone with chert }	-	-	-	190
2.	Solid white limestone	-	-	-	110
3.	Toadstone	-	-	-	4 to 6
4.	Massive white limestone	-	-	-	180
5.	Toadstone.				

The above section is drawn up from personal observations and information from quarrymen and others, the thicknesses being from Horizontal section, Sheet 70.

The Toadstone No. 3 was seen in a quarry a little south-east of the Bull Ring. It is a crumbly, ashy looking bed, pale grey with green specks, and contains pebbles of limestone, one of which was seen as big as a man's fist. The upper surface of No. 4 was very much furrowed and worn into pot-holes, perhaps by the action of water percolating through the toadstone.

Notes on the Hucklow Edge Great Vein, Eyam.

This lode was some time back one of the richest and most largely worked in the county. The mines were drained by an adit known as Stoke Sough, emptying itself into the Derwent a little above Stoke Hall; but when the workings had been carried down to the level of this sough, they were given up because there was no means of getting rid of the water; and with the two exceptions mentioned below the mining operations are now confined to "plunder," that is, ore ungotten in the old workings, or "spoil banks," which are found worth washing over again for the ore left by the imperfect methods of the old miners. Fresh ventures have been started, and pumping engines put up of late years, at Great Hucklow and Lady Wash mine.

At the High Rake shaft, about a mile and a half N.N.E. of Tideswell the following beds were passed through.

*Section of the High Rake Mine.**

						Feet.
1.	Limestone	-	-	-	-	117·0
2.	Clay	-	-	-	-	2·0
3.	Limestone	-	-	-	-	42·0
4.	Clay	-	-	-	-	1·0
5.	Limestone	-	-	-	-	117·0
6.	Toadstone, not gone through	-	-	-	-	132·0

In another shaft they sank through 72 fathoms, other accounts say 80, of the toadstone without getting through it, and the attempt was at last given up. Some ore was found in the toadstone.

From a quaint old geological work† we have extracted the following account and plan of the mines on Tideswell Moor: "On Tideswell Moor,

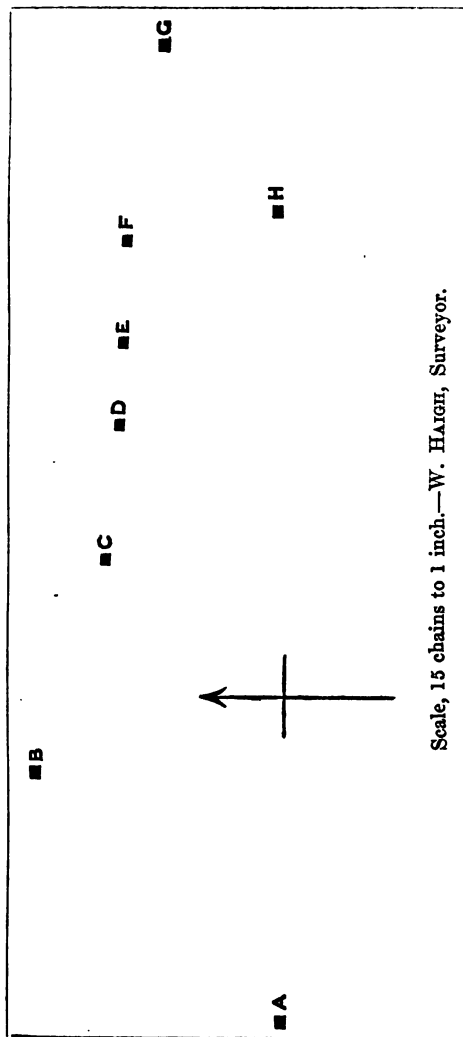
* From a section in the office of Mr. Bagshaw of Foolow.

† An Inquiry into the Original State and Formation of the Earth; deduced from Facts and the Laws of Nature. To which is added an Appendix, containing some general observations on the strata of Derbyshire, &c. By John Whitehurst. 4to. London, 1778. We are indebted to our colleague, Mr. Whitaker, for the extract.

“ the toadstone, or channel as there called, has been dug one hundred
 “ fathoms deep, and no bottom found ; though in seven other mines
 “ adjacent the same stratum has been dug through and its thickness
 “ ascertained at each place as under :

				Fathoms.	
“ A. Black Hillock	-	-	-	-	100, not cut through.
“ B. Heath Bush	-	-	-	-	16, cut through.
“ C. St. Andrews	-	-	-	-	2, do.
“ D. St. James	-	-	-	-	12, do.
“ E. Constant	-	-	-	-	7, do.
“ F. Calvestones	-	-	-	-	7, do.
“ G. Dunkirk	-	-	-	-	19, do.
“ H. Chap maiden	-	-	-	-	17, do.”

Fig. 4.
A Plan showing the relative Positions of the Mines on Tideswell Moor.



If the above account be trustworthy it is not unlikely that the Black Hillock shaft was just on one of the vents through which the toadstone

came up; Farey, however, thinks that in the seven last mines Mr. Whitehurst has mistaken some occasional or "chance" beds of toadstone for the main mass. (Conybeare and Phillips' *Geology of England and Wales*, p. 450.) There can be no doubt, however, about the fact that in one shaft a great thickness of toadstone was met with and never got through.

At Great Hucklow there are two mines at work, one of which by the order of Mr. Moore of Bamford was kindly thrown open to us.

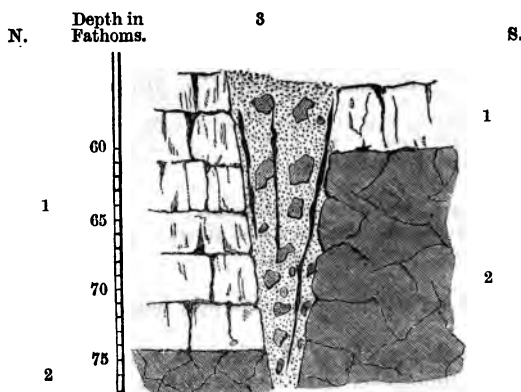
The lode runs nearly east and west. A section across the lower part is given in fig. 5. It is a rent 50 yards across at the surface, but narrowing down to 10 yards at a depth of 66 fathoms, filled in with spar or "kebble," chiefly carbonate of lime, but a little heavy spar also occurs. Embedded in the "kebble" lie many large detached blocks or "horses" of limestone and toadstone. Through this broad vein there run narrow, irregular strings of galena, two of which, one near the north and another near the south wall, can be worked with profit; here and there a third vein has been worked between the two. The lode is a fault with a downthrow to the north, and at this mine the throw was about 12 fathoms. In the 60 fathom level a clay parting or "clay joint" a few inches thick was crossed, blue in the upper half and brown below; it was not unlike decomposed toadstone. There is said to be a second "clay joint" below this.

The top of the toadstone is reached on the south side of the lode at a depth of 62 fathoms, and we were told that the 60 fathom level had been driven to the west beyond the point where they ought to have struck the toadstone, if it had the same dip as the limestone, but that they had not yet met with it. If this be really the case, and if, as there is every reason to think, the toadstone is an interbedded igneous rock, either it must thin out very rapidly to the west, or there must be some cross fault of which the miners are not aware.

In the 66 fathom level they were working the vein of galena on the south side; it was only an inch thick, but on the day before our visit it had been five inches thick, and it sometimes widens out to three feet. It is interesting to note that here, where the wall is toadstone, the string of galena lies at some distance from it, while higher up, where the wall was limestone, the vein bore best close to the southern cheek. It is also worth notice that whereas in the upper part of the lode the "horses" were all limestone, we find here in the neighbourhood of the toadstone wall "horses" of decomposed clayey toadstone.

At the 75 fathom level both walls of the lode are toadstone, but till the workings have been pushed on farther it is impossible to say how the vein will bear here.

The toadstone is an amygdaloidal rock, as is very beautifully shown where it has decomposed into a soft friable clay. For by washing this, or merely rubbing it between the hands, one may pick out the small rounded or almond-shaped kernels of carbonate of lime, which once filled the cavities in the vesicular rock. These pieces of carbonate of lime are coated with a green mineral, and the rock thus acquires a speckled look, showing green spots on a yellowish brown ground.

*Fig. 5.**Section across a part of the Lode at Great Hucklow.*

Scale, 80 feet to 1 inch.

1. Limestone.

2. Toadstone.

S. Lode filled with "kebbles," and "horses" of limestone and toadstone; black lines, strings of galena.

Section near Stoney Middleton.

There is a section worth notice in the upper part of the limestone given by large quarries at the bottom of Combs Dale near Stoney Middleton. The beds are rather irregular, and the two following sections were measured in different parts of the quarry:

Section in Combs Dale.

	ft.	in.		ft.	in.
Thinly bedded limestone with seams of chert, about	20	0	Thinly bedded limestone with seams and nodules of chert, about	20	0
Dark, iron-stained shale	0	3	Bright, clean coal	0	2
Bright coal	0	1	Light-grey fire clay	1	6
Light-grey fire clay	0	9	Yellowish sandy clay, with a thin layer of oxide of iron at the bottom	0	3
Thickly bedded limestone.			Thickly bedded, light-grey limestone, joints lined with oxide of iron	7	0
			Light-grey clay, iron-stained here and there	1	0
			Thickly bedded, grey limestone.		

Thin clay partings are not uncommon in the limestone, but we have nowhere else in Derbyshire noticed any traces of coal in this rock. These little beds seem to show that the formation of coal, which went on on a small scale during the Yoredale and Millstone Grit periods, and after showing a marked increase in the Ganister beds reached its fullest development during the time of the Middle Coal Measures, began here and there even so far back as the end of the Limestone epoch.

Ashford.

The following section of the Dirlow Mine near Ashford, copied from an old plan in the office of Mr. Bagshaw of Foolow may be worth recording here.

Section of the Dirlow Mine.

	ft.
Black limestone - } - - -	90
"Channel" (toadstone) - - -	
Black limestone - - -	60
"Channel," irregular in thickness.	
White limestone, thickness not given.	
"Channel," not cut through.	

This is valuable as proving the existence, here at least, of *three* beds of toadstone.

The famous black marble of Ashford is a dark, earthy, and most likely bituminous limestone. In the quarries at Ashford there must be nearly 200 feet of limestone above the beds which yield the marble ;* immediately over it are thinly bedded limestones with chert and two layers of black shale. The marble is found in thin beds with partings of shale and layers of black chert, the productive band being about nine feet thick. It has a smooth fracture and rings clearly under the hammer ; the surfaces of the slabs were covered with the rounded ripple markings so common on flagstones, and there were also other marks, some of which were sun-cracks, some perhaps worm tracks, and some it may be fucoids. It is clearly only a local variety of some of the beds of the upper cherty series of the limestone.

Note on the Mill Close Mine, Winster.

This mine, which has for the last few years proved very rich, is the property of Mr. E. M. Wass, who kindly gave us leave to go over it. The shaft is on the hill side south of Cowley Knoll, and about 1.4 mile N.E. of Winster Church. The following measures were passed through.

Section of the Mill Close Mine.

	ft.
Shale with beds of earthy limestone, belonging to the lowest group of the Yoredale Rocks -	240
Limestone - - -	150
Band of deep-black clay, without bedding -	1
Soft, crumbly, greenish ash - - -	4 to 5
Toadstone. { Solid toadstone, consisting of large lumps of amygdaloidal ashy rock, embedded in softer but similar rock - - -	44

The lode is of very irregular width ; the vein stuff mostly semi-transparent calc-spar, crystallized in large rhombohedrons, mixed with a good deal of chert, of a dull yellowish colour, and differing from the chert of the limestone in being soft and crumbly ; it has perhaps been altered by some chemical action. The vein is occasionally split

* This marble was erroneously stated in the Explanation of Horizontal Section, Sheet 42, to lie in the lowest group of the Yoredale Rocks.

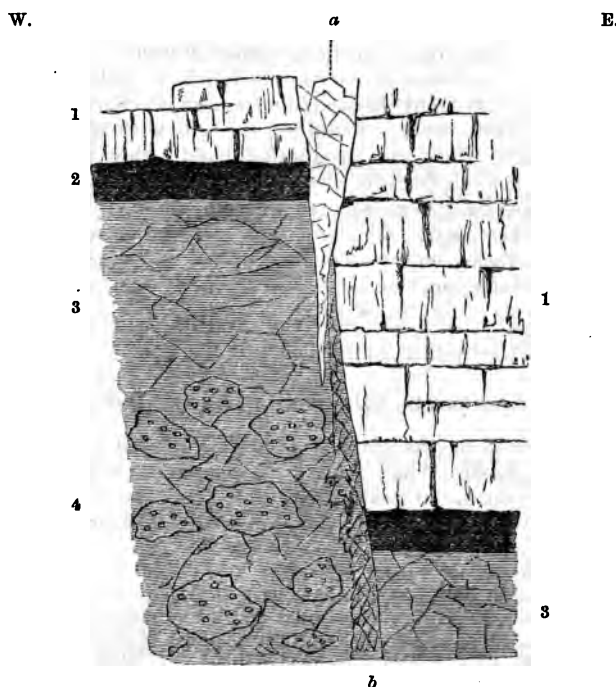
up by very large "riders" of limestone. Branching from the main vein are chambers or "pipes," often very large and almost entirely filled with ore; these follow in a general way the direction of the bedding. Thin layers of ore and spar also run out between the limestone beds.

On the vein reaching the toadstone it is "pinched" into a "leader" a few inches broad, of white, opaque, imperfectly crystallized calc-spar, and even this soon thins away downwards.

Fig. 6 is a section across the lode at this point; the limestone wall on the east was most beautifully clean cut and slightly polished; the toadstone rather crushed and ground up against the fault. The throw is about three yards.

Fig. 6.

Section across the Lode at the Mill Close Mine.



Scale, 5 feet to 1 inch.

1. Limestone.
2. Black bituminous unstratified clay.
3. Soft, crumbly, greenish toadstone.
4. Irregular masses of amygdaloidal ashy toadstone, embedded in softer but similar rock.
- a.* "Leader" of Calc-spar.
- b.* Belt of Toadstone crushed against the fault.

At the time of our visit a heading had been driven through the toadstone and traces of the vein found below, but they had not then gone far enough to be able to say how it would turn out.

Matlock.

The following section of the measures hereabouts was given us by an old miner :

Section at Matlock.

		ft.	in.
1. Limestone and chert	}	-	-
2. Massive limestone			
3. Shale with Ironstone nodules and <i>Calamites</i> *	-	170	0
4. Toadstone	-	2	6
5. Massive white limestone, with three thin partings or "way boards" of clay or shale	-	30	0 to 77 0
6. Toadstone	-	}	Thicknesses not given.
7. Limestone	-		
8. Toadstone	-		

In his "General View of the Agriculture and Minerals of Derbyshire" (page 129), Farey gives the following section of these beds :

Section at Matlock. After Farey.

	ft.
Grit (? Yoredale Grit)	-
Limestone shale	420
1st Limestone	150
1st Toadstone (in face of the High Tor)	60
2nd Limestone	150
2nd Toadstone (at foot of the High Tor)	90
3rd Limestone	204
3rd Toadstone	90
4th Limestone	-

The two following sections are given in Pilkington's "View of the present State of Derbyshire," pp. 51 and 55 :

At Snitterton, 1½ mile W.N.W. of Matlock.

				ft.
Limestone with chert	}	-	-	150
Dun-coloured limestone				
"Blackstone" or Toadstone		-	-	74
Limestone	-	-	-	48
Clay bed	-	-	-	1
Limestone	-	-	-	90
"Blackstone," said to have been proved to be 240 feet at a mine called "Porter," two miles south of Snitterton, and found to be 90 feet two miles south-west of Snitterton.				
Limestone, thickness not ascertained.				
Blackstone.				

Between Grange Mill and Darley Moor.

	ft.
Gritstone	360
Shale	360
Limestone	150
"Blackstone"	48
Limestone	150
"Blackstone"	48
Limestone	180
"Blackstone"	66
Limestone	-

* There are some very fine specimens in the High Tor Cavern, which we were assured came from this bed.

The railway cutting immediately to the north of Matlock Bath Station shows the upper beds and gives the following section :

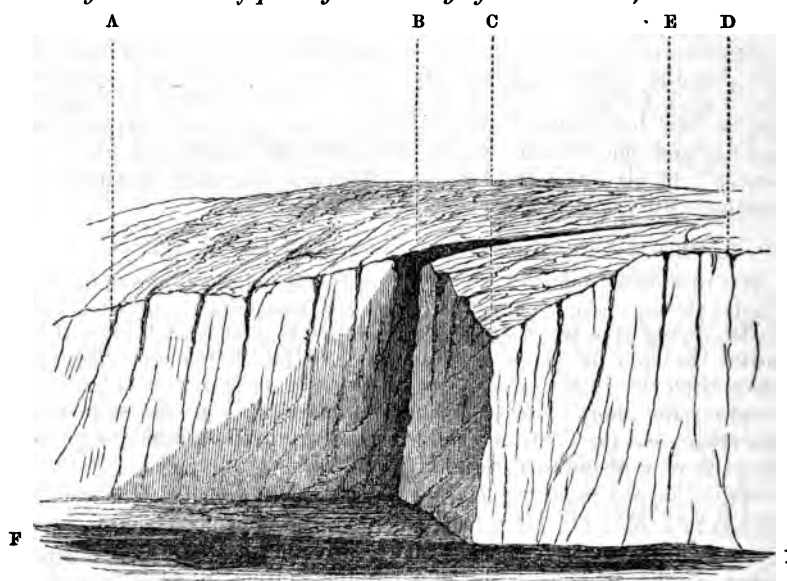
Section in the Railway-cutting at Matlock Bath Station.

	ft.
1. Thinly bedded limestones with chert - - -	—
2. Thickly bedded, whitish limestone - - -	97
4. Toadstone, rudely bedded and somewhat concretionary : mostly solid, but here and there, and especially in the bottom three feet, soft and crumbly. Dirty olive-green colour, with red stains - - -	70
5. Thickly bedded limestone. No sign of alteration at the junction with the toadstone.	

No. 3 was not present here, but the miner assured us that it was found in the sinkings, and showed me some *Calamites* which he said were from this bed.

The same group of beds is shown in quarries on the opposite side of the river, and the toadstone No. 6 has been proved in a heading driven into the rock at the foot of the High Tor.

The so-called High Tor Cavern is well worth a visit. It is a fissure, probably a joint which has been enlarged by water, about 600 feet long, from two to seven feet wide, and 150 feet deep, down to the lowest point of the artificial pathway along the bottom, to make which the deeper parts were filled up. It runs nearly parallel to the steep westerly face of the High Tor, and gives us a clue as to how this cliff, thought in the old days of cataclysmal geology to be the face of a fault, may have been produced. In the sketch-diagram given in Fig. 7 the cliff AB which bounds the valley coincides exactly with the line produced of the fissure of the High Tor Cavern, BE. And here surely we see before us cause and effect. Such fissures are common in the limestone, and, by furnishing a line along which the rock, when undermined by the river or underground streams, breaks off most readily, determine the steep cliffs which so often bound these limestone valleys. Such a fissure was doubtless the cause of the cliff of the High Tor, CD, which at one time may have reached farther to the north than it now does, the recess ABC being then filled with a solid mass of limestone up to the top of the cliff. After a while, however, the river began to attack this mass of rock too, and worked its way back to the second fissure of which the High Tor Cavern is now the only remaining part, so giving rise to the cliff AB. There the process ceased ; but if the river now retains, or should it ever recover, its power of destruction, the mass BCDE will in time go too, and what is now the eastern face of the High Tor Cavern will become the boundary cliff of the valley in the place of the precipice of the High Tor.

*Fig. 7.**Diagram Sketch of part of the Valley of the Derwent, Matlock.*

AB. Cliff bounding the valley.
BE. Fissure of the High Tor Cavern.

CD. Cliff of the High Tor.
F. River Derwent.

Wirksworth.

The neighbourhood of Wirksworth is interesting as showing well beds of Dolomite interbedded with the usual blue limestones of this formation. The general section noted hereabouts was as follows.

*Section about Wirksworth.**

- | | | | | |
|--|-----------------------------|---|---|-------------------------------|
| 1. Limestones, mostly in thin beds, with | nodules and layers of chert | - | - | feet. |
| 2. Thickly bedded limestones | - | - | - | 500 without reaching the top. |
| 3. Toadstone | - | - | - | 100. |
| 4. Dolomitic limestone | - | - | - | 400. |
| 5. Massive white limestone. | | | | |
| 6. Toadstone of Hopton. | | | | |

The upper toadstone may be seen in a cutting of the High Peak Railway, about a mile north-west of Wirksworth.

The dolomitic rocks run up into masses with a rudely castellated and sometimes spiry outline, as at Harboro' Rock, about two miles west of Wirksworth.

The lower toadstone at Hopton is a very coarse brecciated ash, with beds of greenstone.

The few sections just described, which are all we have been able under the circumstances already mentioned to obtain, are drawn out to

* The thicknesses are from Horizontal Section of the Geol. Survey, Sheet 60.

scale in Fig. 8, p. 32. In the present state of our knowledge it will be useless to speculate on the possible identities of the beds; but it looks as if the toadstone bed No. 4. Sect. I., No. 5. Sect. II., No. 6. Sects. III. and V., No. 3. Sect. VI., and No. 7. Sect. VIII., though very changeable in thickness, keeps pretty nearly a constant horizon throughout; this will be the "Second Toadstone" of Farey and the old geologists. The exact horizon of the beds in the High Rake Mine is doubtful; but, if we have placed them correctly, the agreement between this section and the Crich beds, even in such small matters as the "way boards" of clay, is worth notice. Between the other details of the measures little or no correspondence can be traced.

We may now turn to the boundary of the Mountain Limestone, which winds through the country with many a sharp turn and re-entering angle, owing sometimes to faults, sometimes to sharp foldings of the beds. In spite of these irregularities the line is not very difficult to trace, for even in the absence of sections there is a marked difference between the short sweet turf of the limestone, and the sour rushy growth on the overlying shales: sometimes, too, the junction is marked by a line of swallow-holes, into which the streams which drain the surrounding country sink on reaching the limestone, and continue their course underground.

We will start at the Odin Mine near Castleton,* the extreme northern point of the limestone tract, and work our way round along its western, southern, and eastern edges.

Between our starting point and Buxton the boundary is at some spots formed by faults, which bring the lower, thickly bedded, white limestones against the Yoredale shales, while at others these latter are regularly overlaid by the upper, thinly bedded, cherty limestones: along part of the line there is not evidence to determine whether the boundary is a fault or not.

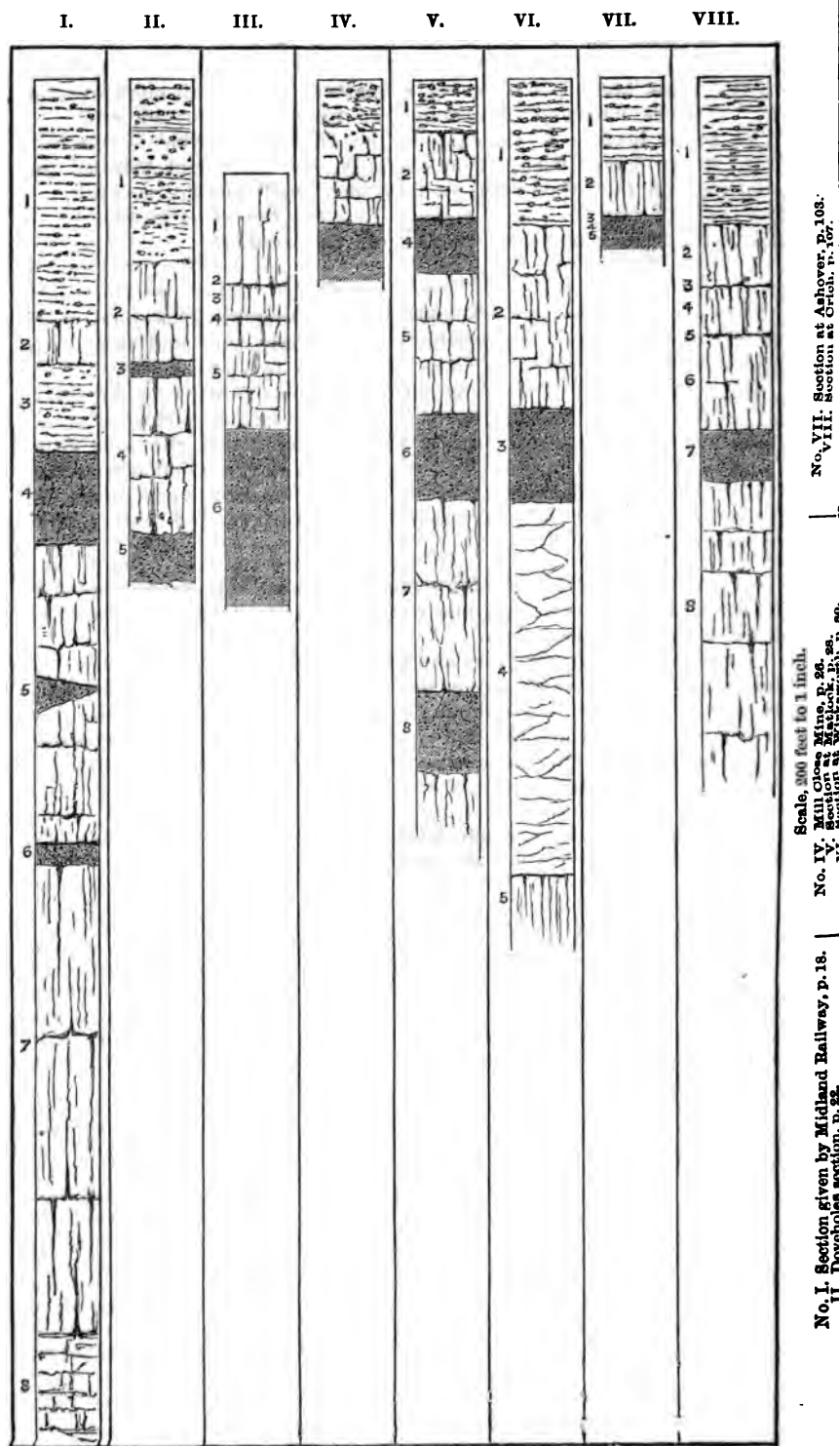
The hills, Treack Cliff,* Windy Knoll,* and Middle Hill,* are all formed of massive white limestone, and we nowhere find any trace of the upper cherty beds, and the limestone must, therefore, here be bounded by a succession of faults. From Middle Hill to Perryfort,* the shape of the ground points to a natural junction, and the line is well marked by a line of swallow-holes; it is rather doubtful, however, from the character of the rock whether it belongs to the topmost beds or not, and therefore the question whether the boundary is a fault or not must be left open. Between Perryfort and Sparrow Pit* the boundary seems faulted, but on turning down the road from the latter point to Chapel-en-le-Frith, we find the upper cherty beds dipping below Yoredale shales at angles of 15° to 30° . We shall show below, however, that a fault must run between the limestone and the Yoredale grit of Bolt Edge.*

Turning down the valley to Buxton,† we find many sections showing the upper cherty beds of the limestone passing regularly below the Yoredale black shales, and the boundary though broken by cross faults is a natural one. Between the top of the limestone, however, and the base of the Yoredale Grit to the west, there is room for only about 500 feet of measures, see Horizontal Section of the Geological Survey, sheet 70. As the combined thickness of the two lowest groups of the Yoredale Rocks is most likely far greater than this, a fault must lie between the two. In the tunnel of the Midland Railway at Doveholes, a fault was crossed a little to the west of the junction of the limestone and shale, and we have already seen that in the railway cutting east of Buxton the limestone is faulted against shales (p. 20, fig. 2); between these two points, then, we have drawn the fault, keeping it a little to the west of the limestone boundary.

* In Map 81 N.E. see p. 46.

† In Map 81 S.E.

Fig. 8.
Comparative Sections of the Mountain Limestone.



We have mentioned in the memoir on sheets 81 N.W. and S.W. (p. 49) that a fault most likely runs between the Mountain Limestone and Yoredale Grit at Buxton, but we have no further evidence to offer.

From the house called The Pecks,* a mile and a half west of Buxton, a line of faulted boundary reaches to beyond Hartington. The existence of this fault was pointed out by Farey, and though his generalisations were somewhat too sweeping, and many of his statements have to be modified when we come to details, yet the keen-eyed old geologist was here at least right in the main. Farey's views will be found in a paper in the Philosophical Transactions for 1811, entitled "An account of the Great Derbyshire Denudation, by Mr. J. Farey, senior. In a letter to the Right Hon. Sir Joseph Banks." A capital summary is given in Conybeare and Phillips' "Outlines of the Geology of England and Wales," p. 450. We also gave our reasons for suspecting some such fault in the Memoir on the adjoining quarter sheet 81 S.W. (pp. 48, 49), and a detailed examination has confirmed our first impressions. The following considerations lead one to suspect the boundary to be a fault. The limestone mostly rises from the plain or valley to the west in so steep a cliff that nothing short of a dip nearly vertical could carry it below the Yoredale shales which occupy that valley. The junction of the shale and limestone can be traced with great accuracy; and, when laid down on a map, we see at a glance, from its notched outline, that, if not a fault itself, it is broken by many cross faults. Specially we notice the way in which the boundary winds *back* up many of the valleys which cut across it. As the fall of the valleys is in the same direction as the dip of the beds, a tongue of limestone, longer as the dip was smaller, ought to run *down* each valley, while in fact we constantly find a wedge of shale running *up* the valley into the body of the limestone, and abutting on either side against cliffs of that rock in which the beds are seen to lie nearly flat. This, of course, can only be accounted for by faults bounding the valley on either side, and meeting at the point of the wedge. The lower part of Glutton Dale is a capital instance.

On examining the line more closely we find the upper cherty beds everywhere wanting, the rock immediately in contact with the shales being a massive white limestone, such as is only found some way down in the formation; also the limestone is sometimes seen close to the boundary to be rising to the west; and, lastly, we shall be able to point to a few sections where the faulted boundary is actually seen. In spite of these explanations we are not without fear that the extremely complicated array of faults laid down on the map will be looked upon with suspicion, and treated as a bit of fancy mapping. We have ourselves, however, such perfect confidence in the accuracy of the lines and the sufficiency of the evidence, that we begin to believe that a large fault, if it could be traced with the same minuteness as in the present case, would always be found to have a like broken and jagged line, and that the lines we are usually obliged to be content with as showing the course of faults are only very rough approximations, giving their general direction, but by no means all their windings and sharp bends.

Mostly this series of faults brings black Yoredale shales directly against massive white limestone. Here and there, however, when the throw has not been so great, or the denudation has reached lower down, small patches of the upper cherty beds of the limestone are found on its down throw side.

The following points are worth special notice:

In the long tongue of Yoredale shales which runs up between the farm houses Stoop † and Green Sides, † the eastern boundary fault was marked by a line of

* In Map 81 S.W.

† In Map 81 S.E.

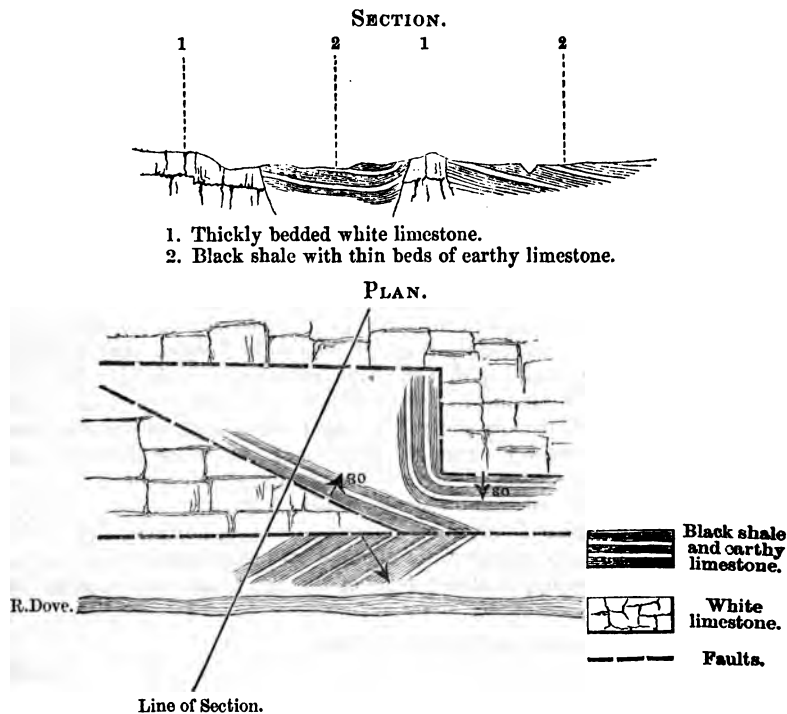
swallow-holes, in some of which black shales were seen abutting against massive white limestone. The fissure here and elsewhere was filled with crumbly oxide of iron.

The sharp peaks of Park* and Chrome hills,* which we had often seen from a distance, are so widely different from the usual rounded outlines of the limestone country, that they had long been a puzzle to us. On the spot, however, the explanation is easy enough. They are masses of limestone bounded by faults on all sides; and while the softer shale, which once reached to their tops, has been carried away by rain and atmospheric wear, the hard limestone has held out against these attacks, and stands up like the conical mounds of soil often left in a railway cutting by which the contractor measures how much has been dug away. Behind these hills is a broad flat-bottomed amphitheatre, at the head of which stands the farm house Dowel,* shut in on three sides by steep limestone hills, and cut off from the shale flat to the west by a narrow wall of limestone rock. A stream crosses this, running above the farm house in a deep, narrow, steep-sided limestone gorge, then winding across the flat, and escaping through another narrow cleft in the western limestone wall into the Dove. And here the same explanation applies. The amphitheatre is occupied by a mass of shale which has been let down by four faults into the limestone, and which once filled the hollow up to the top of the bounding hills. The stream has cut a channel across; and those parts of its valley which are in limestone are still narrow, because that rock does not easily break up under the action of the weather; the shale, on the other hand, crumbles more quickly and is washed by rain and rivulets into the brook and so carried away, and therefore in it the valley has been widened out, up to the edges of the harder limestone.

At Crowdecote,* we found the section given in fig. 9. It shows how complicated is the faulting along this line, but the details could not be put on the small one-inch map.

Fig. 9.

Section and Plan to show the faulted nature of the Limestone Boundary at Crowdecote.

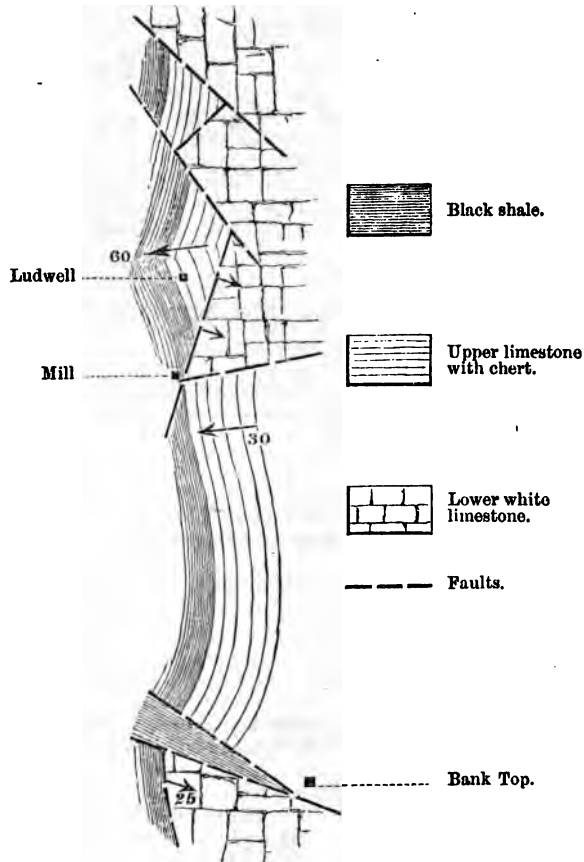


* In Map 81 S.E.

At Ludwell* is a very complicated bit, the details of which are shown in fig. 10. Opposite the mill the limestone was rising to the west steeply enough to carry it *over* the Yoredale shales on the opposite bank, unless a fault ran between.

Fig. 10.

Plan of the Limestone Boundary at Ludwell.



From Bank Top* to Hartington* there runs a clear line of crags of *white limestone*, dipping *east* at 25° , and with black shale abutting against them on the west; the boundary, therefore, for two reasons, must be a fault.

This clear and undoubted line of faulted boundary ends at Narrow Dale,* and from here to Caldon, we have a very complicated and often obscure line, partly a natural superposition, and partly formed by faults.

The rock that is found at Narrow Dale immediately in contact with the shales is a brown slabby limestone, crammed with encrinites and other fossils; we do not know the position of this rock in the series, nor even if it marks any definite horizon, and therefore can learn nothing from it as to whether the boundary is a fault or not. The ground too is a good deal masked by Boulder Clay; and at one part the only guide we had for the position of the boundary was, that on one side of a line the ground was covered with swallow-holes, and on the other

* In Map 81 S.E.

side there were none; and in default of better evidence we took this line for the boundary.

The rock round the flanks of Wetton Hill* is the same brown encrinital limestone, but in the brook below Pepper Inn† a good junction was found of the Yoredale shales and upper cherty beds of the limestone; and these beds may, for all we know, wrap round the whole of the hill under a covering of turf. This bit, therefore, we must be content to leave doubtful.

There is a small patch of shale about Hope Marsh,* most likely a detached outlier. But Boulder Clay will not allow us to speak with certainty.

The boundary along the western side of Ecton Hill† must be a fault, unless the beds are on end or nearly so: they seemed to be so at one spot, but as this line was marked as a fault on former editions of the map, and we have no certain proof to the contrary, we leave it as it was.

The fault leaves the boundary, however, before Apes Tor,† for here there is a section (Fig. 11, page 37,) showing a natural junction.

Hence round the northern end of the Ecton mass we get sections showing upper cherty beds dipping below Yoredale shales. Below is a good section in the lower part of the latter, given by a quarry a quarter of a mile south-east of Warslow Hall.†

Section near Warslow Hall.

	ft.	in.
Earthy limestone	-	2 0
Hard, slaty, black shale, with beds of earthy limestone	-	5 0
Solid, grey limestone, full of encrinites and shells	-	6 0
Thin, irregular band of chert.		
Black, slaty shales with thin beds of earthy limestone.		

It is hard to say whether these beds should be put in the bottom of the Yoredale Group or the top of the Mountain Limestone. The black shale led us to give them the former place; but they serve to show how gradual passage is hereabouts.

East of Warslow the ground becomes covered with Drift, and we see nothing till the spot where the road from Warslow to Swanslow Head crosses the brook.† Here Yoredale shales are faulted against white limestones. Nearly three quarters of a mile to the south a similar bit of faulting is shown in a brook. From these two sections we conclude the boundary is a fault running down to the farm-house Wallace, about which are some quarries showing beds tilted and dipping to the east. From here a broken line of faults seems to bound the limestone down to the north side of Grindon.* These faults, however, do not throw the limestone entirely out of sight, for it comes out in the bottom of the valleys and rises into a knoll of some height at Butterton. The ground, however, is covered with Drift and the details obscure.

From Grindon down to Caldon* we find the upper limestone beds dipping, mostly at high angles, beneath the shales; the boundary being broken by faults at Deep Dale* and Waterhouses.*

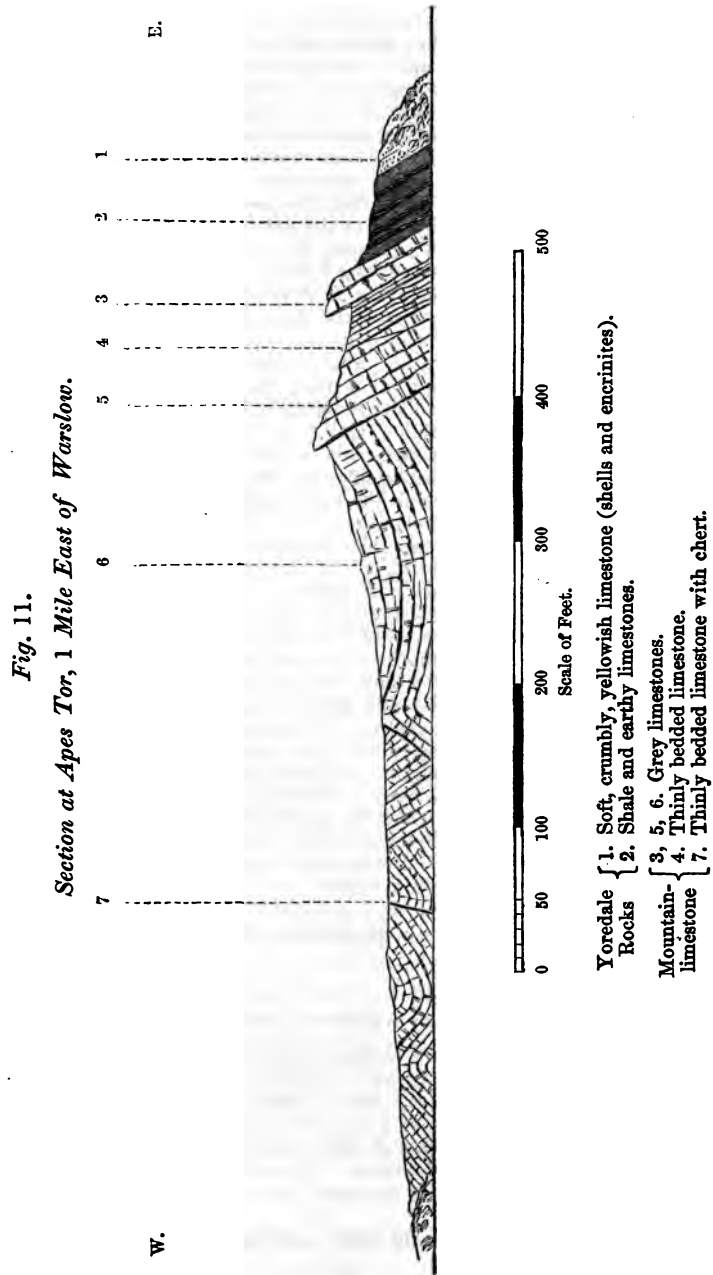
At Caldon* we reach the great mass of the Weaver and neighbouring hills; they consist of massive white limestone up to the boundary, without any trace of the upper beds, and rise with bold steep sides from the shale plain. The boundary here, therefore, must be a succession of faults.

Between the Weaver Hills and Wirksworth the following details are worth notice.

Rounding the projecting mass of the Weaver Hills, we come on the upper beds again at Thorn's Wood,* and can trace a natural boundary thence up to Calton Moor, T. G.,* where is a very complicated and faulted bit of ground, the details of which, however, are luckily very clear: several of the boundaries are given by lines of swallow-holes, and the contrast between the dry soil of

* In Map 72 N.E.

† In Map 81 S.E.



as The Peak, though how it can have come by the name is difficult to see, for there are no pointed hills upon the broad table land which it forms. It is roughly triangular in outline, and the escarpments of the rock, with which it is capped, form, nearly all round it, lines of wild craggy cliffs, through which streams have eaten deep, rugged gorges, that wind far back into the heart of the hill, and have a stern, solitary grandeur that is very striking. The deep cloughs running up from Edale, and Fairbrook Clough, are among the most noticeable; a sketch of the latter is given in Fig. 12, page 41. The cliffs in the distance mark the escarpment of the Kinder Grit, the steep hill side below being formed of the underlying shales; while the softer and more gently rounded hills in the foreground and middle distance are Yoredale Grit, through which the stream has worked a deep valley.

The scenery on Kinder Scout is also very wild and impressive, specially about the Downfall, where the stream in wet weather tumbles over a precipice of grit, around which fallen masses of the rock are strewn in wild confusion.

The upper surface of the plateau is covered with a considerable thickness of peat; bosses of grit, however, stand up here and there, and have been worn by the weather into the queerest and most unlooked-for shapes (see Frontispiece). It at once strikes the eye that a very large number of these rocks are undercut, or worn away more in the lower than the upper part: this was for a long time a puzzle to us; if the rocks had been all pretty much on the same level, it might have been that the upper parts of all the weathered blocks belonged to the same hard bed, and the lower parts to one somewhat softer; but they are found scattered up and down at very different heights, so that this explanation would not do. Professor Ramsay on his visit threw out the following hint on the matter. The rock, wherever it is exposed to the air, weathers down into coarse sand, which lies thick over those parts of the hill top which are bare of peat. During high winds this sand is of course blown against anything that comes in its way, and acts like a natural file or emery powder; but as the wind cannot lift the heavy grains far from the ground, it is the lower part of the obstacle that will be most worn away, and hence the rocks are hollowed out below. If anyone doubts whether the means assigned are sufficient for this end, we recommend a visit to the spot during a moderate gale, and an attempt to hold the head a few feet from the ground with the face towards the wind. It is clear that in time large masses of rock might be thus carried away altogether, by what may be called æolian denudation.

We will now take a hasty run round the edge of the hill, noting anything worthy of remark as we go.

At the Ordnance Station, at the north-west corner, the beds dip S.E. at 10° : the dip keeps the same amount along The Edge, but gradually changes its direction till at Fairbrook Naze it is a little west of south. Near the top of Upper Redbrook is a very curious overhanging weathered rock. The base of the grit is well shown in several of the little gorges that look like slashes in the hill side, in Fairbrook, and again in Blackdean Brook and Jagger Clough. At the western end of Blackdean Edge are some fine weathered rocks. Along Blackdean Edge the rocks seem to have a south-easterly dip, but in Jagger Clough the dip is due west at 5° . Along the southern flank of the hill the dip is a little west of north, from 10° to 15° . The deep, gloomy gorges, such as Grindsbrook and Crowden Cloughs, that cut far back into the escarpment, are very grand and lonely with their rugged cliffs of gritstone frowning down from above. At Edale Head we have the largest group of the weathered rocks already mentioned: they are of every conceivable shape, and cover

Fig. 12.
Sketch of Fairbrook.



several acres of ground. A group is figured in the frontispiece. The base of the grit is clearly shown round Kinderlow End, but hence northwards it is hidden for some way by large landslips; we find it again in the brook below Cluther Rocks and at the Kinder Downfall, after which the side of the hill is again covered by huge landslips, and it is not possible to fix the line exactly till a little before the Ordnance Station at the north-west corner, where we began our circuit.

From the directions of the dip as we go round the hill it appears that the rock on the top of the Peak lies in a very flattened basin, the beds on all sides dipping gently into the hill. It is to this most likely that the outlier owes its preservation.

Kinderlow Cavern is not easily accessible. The entrance is through a fissure nearly vertical, and it is likely that the cavern itself is a large rent, caused by the rock having parted along a joint and slipped slightly forwards. Appalling legends prevail in the neighbourhood of rash explorers who have lost their way and been imprisoned for a whole night in the cave.

We will now once more make the circuit of the Peak, but at a lower level than before, and examine the sections given by the different brooks that flow down from the edge of the table-land.

In the upper part of a brook north of the words "Ashop Head" there is much disturbance, produced most likely by two lines of fault, of which we get fuller evidence to the north. Below this troubled ground the beds have a regular dip, from 10° to 15° , south, or a little west of south, and the stream soon enters the main mass of the Yoredale Grit, of which it yields a good section, showing sandstones, with a little coarser grit, interbedded here and there with shale.

In Upper Redbrook we have the following section:

Massive coarse grit, mixed with finer and more thinly bedded grit	} Kinder Scout Grit.
Shales with a few thin sandstones, about 300 feet (1a)	
Interval hidden by rubbish	} Yoredale Beds.
Sandstone and fine grit	
	Yoredale Grit (1b)

In Nether Red-brook, about 50 feet below the base of the Kinder Scout Grit, there is a bed of grit in the Yoredale shales (1a), about 12 feet thick, with grains about the size of wheat.

In the two Yates Cloughs some beds of the Yoredale Grit are very coarse indeed, and in parts a conglomerate.

In the brook that runs down from the "C" of the words "Cabin Moss," we have the following section of the Yoredale grit:

1. Grit and sandstone with a little conglomerate.	ft.	ft.
2. Shales with a very few thin sandstones	-	- 100 to 150
3. Sandstone and grit with a little shale	-	- 250 about.

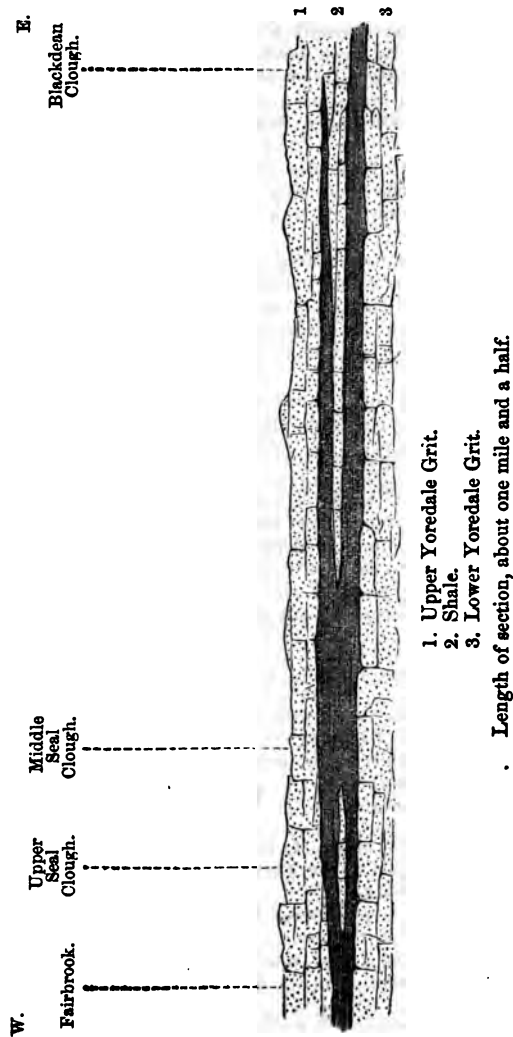
The bed No. 2 in this section is the thickest and one of the most regular of the shale bands in the Yoredale Grit, and divides that mass of rock into two parts, which we may call the Upper and Lower Yoredale Grit respectively.

The next large clough we come to is Fairbrook, which, with its feeders, gives many good sections. In Fairbrook itself we have

Kinder Scout Grit.
Shales, with a sandstone bed near the top, about 300 feet.
Yoredale Grit parted by a thick shale band into Upper and Lower.

Between Fairbrook and Blackdean Clough the beds seem to undergo some very singular and rapid changes, as shown in the following diagram, which has been drawn out from a careful comparison of numerous brook sections made by Dr. C. Le Neve Foster.

Fig. 13.
Diagram to show the changes in the Beds between Fairbrook and Blackdean Clough.



The section in Blackdean Brook shows		
Coarse, massive grit and conglomerate		Kinder Scout Grit.
Sandy shales and sandstone, some coarse		
Sandy shales	Beds marked 1a.	Yoredale Beds.
Thin sandstones and sandy shales		
Bed of grit about 6 feet		
Shale and a little sandstone		
Sandstone, grit and shale beds, about 520 feet	Yoredale Grit, 1b.	
Dark shales and thin sandstones	Yoredale Sandstones.	

The shales below the Kinder Grit contain hereabouts, and specially below Blackdean Edge, a great deal of sandstone, and sometimes grit so coarse as to be scarcely told by look from Kinder Grit: the beds are very irregular and may be seen in the brook courses thinning away and setting in again. In one

case a bed of grit 25 feet thick was seen to die away altogether in as many yards. Owing to the presence of these coarse beds in the shale it is very puzzling to fix the bottom of the Kinder Scout Grit: if we go by mineral character alone, and call all that is coarse Millstone Grit, we put into that formation beds which, when they pass into shale a little further off, we call Yoredale Rocks. We have, therefore, endeavoured to keep the line of division as near as may be on the same geological horizon, without regard to the nature of the rock, and the observer must not be startled should he find here and there beds of even coarse grit in the belt which we have coloured as Yoredale shales round The Peak.

We next have a clear section in Jagger Clough, which shows

Kinder Scout Grit.
 Grey sandy shale with a bed of fine sandstone near the top—150 feet.
 Yoredale Grit.
 Yoredale Sandstones.

The cloughs running down the south face of The Peak into Edale give magnificent sections. The following table shows the thicknesses given by the four best. The measurements were made with a small pocket aneroid, and are of course only very rough approximations.

	Crowden Clough.	Grindsbrook Clough.	Oller brook Clough.	Lady Booth Brook.
Shale - - -	220	325	325	300
Yoredale Grit - -	400	500	425	425
Yoredale Sandstones -	200	200	—	—

The average section will be as follows :

Millstone- Grit.	{	1. Kinder Scout Grit.		
		2. Sandy shale, with tilestone and thin beds of concretionary sandstone - - -	ft.	in.
		3. Yoredale Grit. Massive and flaggy sand- stones, some coarse, with beds of shale -	425	0
Yoredale Rocks.	{	4. Supposed representatives of the Yoredale Sandstones. Thinly bedded hard fine sandstones parted by shale beds -	200	0
		5. Black shales with nodules and beds of earthy limestone : thickness not seen.		

No. 2 are best shown in Grindsbrook Clough.

In the brook running down from Edale Head, just to the east of the "k" in the words Edale Rocks, there are only about 60 feet of shales between the Kinder Scout and Yoredale Grits. We have mentioned how changeable this band of shale is, both in thickness and mineral character, and here we find that between Crowden Clough and the brook just mentioned, a distance of three quarters of a mile, it loses 72 per cent. of its whole thickness.

The ground at the foot of Kinder Scout is so covered by landslips that we get few good sections. In the brook formed by the junction of the streams from Cluther Rocks and Kinder Downfall the Yoredale Grit contains a very large quantity of shale: in fact the shale here equals if not surpasses in bulk the whole amount of sandstone.

There is a very curious encrusting spring on this flank of the Peak. It will be found beside a brook that runs through the first "o" of the words "Mermaid's Pool," half-way between the brook from Cluther Rocks and a wall marked on the map. It has deposited a large mass of calcareous tufa of a dull yellowish colour: it is somewhat difficult to see whence the supply of carbonate of lime comes.

There are, besides The Peak, two small outliers of what seems to be Kinder Scout Grit; one on Mill Hill, north-west of the Ordnance Station, which is somewhat questionable, and the other on Brown Knoll, south of Kinderlow End, about which there is, we think, little doubt.

The sameness of the Yoredale Grit plateau is again a little broken on its eastern side by two small outliers of Kinder Scout Grit, one on Crook Hill and the other on Win Hill. The first, though the lower of the two, is very strongly marked by the rugged crags of its escarpment; these give very clearly the base of the Kinder Scout bed, but the line of the top of the Yoredale Grit is almost wholly conjectural. It is delightful to see how clearly the Kinder Grit has stamped its character on this little outlier; the first glance at it even from a distance is enough to show one, who has got to know the look of the rock, what the capping to the hill is made of.

Win Hill, which rises, a sharp conical peak, to the height of 1,575 feet above the sea, is also capped by a small patch of Kinder Grit. The rock is probably faulted at the west end, and neither its base nor the top of the Yoredale Grit can be fixed with any certainty on account of the large quantity of fallen rock that strews the flank of the hill.

Yoredale Grit round The Peak.

Surrounding The Peak on all sides, and bounded on the west, east, and north by the escarpments of the Lower Kinder Scout Grit, and on the south by the Mountain Limestone, is a ring of country mainly occupied by Yoredale Grit. It bears the general look of a plateau, about 500 feet lower than the table-land of The Peak itself, deeply channelled, and in places almost wholly obliterated, by brook courses and river valleys. The character is best preserved on the west, north, and east; on the south the valley of Edale, over which the plateau must once have stretched in an unbroken flat, cuts off from the main mass the ridge of Rushup Edge and the outlier of Loose Hill; while towards the south-east the valley of the Derwent in the same way severs the high flat ground of Abney Moors, which must originally have formed part of the general plateau.

In describing this broad spread of rock, we will start from Chapel-en-le-Frith and work northwards; then turn to the east till we reach the valley of the Derwent, which we will follow down to Bamford, and finish with the valleys of Edale and Castleton.

The structure of the country immediately to the north-east of Chapel-en-le-Frith is far from clear, and the lines on the map are many of them only approximately true. A fault, passing near the church and running north-west and south-east, was seen in a quarry by the road side between Blackbrook and Barmoor Clough, and it seems to be the cause of the sudden change of dip from N.N.W. to S. which is seen in the section up Ashbourne Lane.

Another fault is seen behind the farm house Plumpton, and in a quarry west of Bagshaw. And there seemed reason to believe that a lode near the place called "Coal Pit" on the map is a small fault, which runs on towards Bowden Head.

A long tongue of the Yoredale Grit runs out along Rushup Edge and Cowbarn to Lords Seat. The rock is best seen in a large quarry on the Castleton Road, a little beyond Slack Hall; it is massive but not coarse. A band of shale, probably not more than 20 feet thick, is very constant hereabouts in the grit; it may be traced by the little terrace made by its outcrop on the hill sides, and could it have been carried on with certainty it would have divided the bed into an Upper and a Lower Yoredale Grit. But further north the shale beds became so numerous and irregular that we could not fix on any that

could safely be looked upon as the equivalent of this bed; and even if this difficulty had been got over at any one point, we should never have felt safe that we did not in our further progress occasionally jump from one shale band to another, so the attempt was given up.

There must be a fault between the Yoredale Grit of Bolt Edge and the Limestone, as there is not room enough to the Lower Yoredale beds between the two. Some indications of this fault were seen in the valley opposite the Ebbing and Flowing Well.

It seems likely also that a fault runs between the base of Rushup Edge and the Limestone boundary, for the following reasons. There are some old shafts on the Odin Lode in a plantation three quarters of a mile E. by S. from the Trigonometrical Station on Lords Seat, which must have gone down to the Limestone, and there does not seem room enough to get in the two lowest divisions of the Yoredale Rocks between the base of the Yoredale Grit on Rushup Edge and the bottom of these shafts. The Odin Lode itself is not this fault, for both its walls are limestone, but most likely the lode and fault are so close together that they cannot be laid down separately on the map. Fig. 17 will explain this.

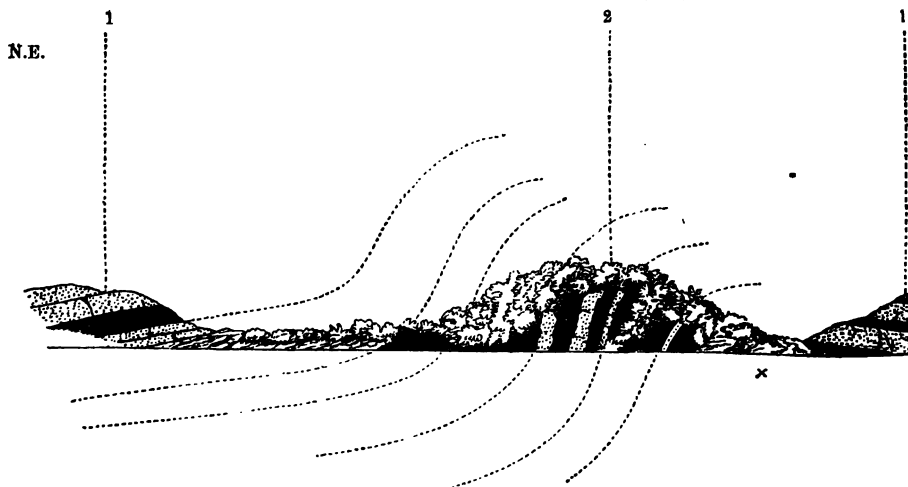
A little to the north of Chapel-en-le-Frith there is a fault ranging E.N.E.; between this fault and another through South Head the structure of the low country is very obscure. The dips are very irregular, and perhaps some of the faults which are found on the north run down to hereabouts. The two valleys of the Roych and Roych Tor give fine sections of the Yoredale Grit, showing between four and five hundred feet of sandstone with shale beds.

In the western part of the plateau of Yoredale Grit, between The Peak and the western escarpment of the Kinder Scout Grit, we find a number of faults having a general north and south trend. Along this line the beds, which on the crest of the saddle are all but flat, begin to bend over sharply to the western dip, and it was most likely this wrench which brought about the foldings and breaks in the rocks.

We will now trace out the main line of disturbance. Contortions may be seen in all the brooks along this line from South Head farm to Kinder Head; at the former they show merely sharp rolls, and the fault is perhaps just dying out; at the latter the beds are on end, and violently contorted for several hundred yards. The section in William's Clough, sketched below, gives us the exact place of the break.

Fig. 14.

Section in William's Clough, showing a fault.



1. Sandstone and Shale. 2. Thin, hard sandstones and sandy shales. x Place of the fault.

On the same line we again find broken beds in Long Grain, two small faults in Bakestone Delph Clough, beds on end in Shelf Brook, and very high dips in the stream through Lightside Plantation. We have, however, scarcely evidence enough to justify us in assuming a fault along the whole of this line, but the beds are certainly faulted both at its northern and southern ends.

The other faults branching from this have been drawn as well as circumstances would allow. They for the most part only bring one part of the Yoredale Grit against another part, and therefore cannot be traced with certainty.

Turning now to the east, we enter a tract nine miles long, with an average breadth of four miles, wholly occupied by Yoredale Grit; it includes Glossop, Alport, Ronksley and Derwent moors, and the district called The Woodlands. The plateau formed by the rock is deeply cut into by many brooks, any one of which will be found to give an admirable section of the measures; but one will serve as a type for all, and there is nothing of special interest except in the valleys of the Alport, Ashop, and Derwent.

The river Alport runs over Yoredale Grit, yielding excellent sections, till about three quarters of a mile above Alport Castles, where it cuts down to the beds taken to be the Yoredale Sandstones. In these beds, though sandstones occur, yet the bulk of the measures is shale, and immediately the river enters upon them its eastern bank begins to be covered with huge landslips formed of masses of the Yoredale Grit which have slid down from the hill top above. They strew the hill side in vast numbers for the whole distance that the river runs through the shale measures, and cease when it again enters the Yoredale Grit immediately.

The most striking of these landslips is Alport Tower, of which a sketch is given in Fig. 15. In the hill side is a large opening, with vertical faces, looking exactly like a quarry, 150 feet high and 28 chains long. The mass of sandstone that once filled this hollow has slipped down into the valley, and breaking up has formed a series of under-cliffs with steep, scarped edges, the highest of

Fig. 15.
Sketch of Alport Tower.



which is peaked in shape, and forms "The Tower." The slipped mass is 12 chains across at its broadest part: many of the hummocks of sandstone are scarcely broken at all by their fall, and still show the same dip and bedding as the unslipped mass above, of which they once formed a part. Below this, quite down to the river bank, the side of the valley is covered by older landslips, the features of which are somewhat hidden by trees, and have lost some of their sharpness from atmospheric wear, but which still have an unmistakable stamp about them. The spot is well worth a visit, both by the lover of scenery, for it is strange and fanciful, and by the geologist who wishes to study the effects of atmospheric action in wearing away a country.

Owing to these slips we get few sections till we reach Alport Bridge. Hereabouts and for some little way up the Ashop we find the Yoredale Grit passing downwards into a mass of dark shale with thinly bedded sandstones, which we look upon as the equivalents of the Yoredale Sandstones: it is, however, all but impossible to draw a line that shall be worth much between them and the Yoredale Grit. Below these beds are black shales with nodules of limestone containing *Goniatites*, which we place in the third group of the Yoredale Rocks;* on this supposition the Yoredale Sandstones will here have a very small thickness. The black shales may be seen in The Alport a little above the bridge, and in a heading that has been driven into them in search of coal (!) between the 14th and 15th milestones on the turnpike road. Some hundreds of pounds were thrown away here under the direction of a "practical miner" who "liked the measures," and gave it as an opinion beyond question that "coal could not be far off."

The river continues to flow over shale measures for about a mile and a half below the bridge, where the Yoredale Grit is again brought down to its level on the south bank by a steep south-easterly dip. The section is very pretty, the beds rearing up at angles of 30° and 40°, and the harder standing out in reefs across the water. On the north side of the valley the exact place of the base of the rock cannot be fixed on account of the landslips, but it is certainly far above the river, and there must be either a very sharp roll over of the beds or a fault such as is drawn on the map. Horizontal Section, sheet 69, of the Geological Survey, which crosses this spot, will explain the lie of the rock.

Hence down to its junction with the Derwent the river flows through the Yoredale Grit.

The river Derwent rises below the northern escarpment of the Kinder Scout Grit and flows through the Yoredale Grit down to Yorkshire Bridge. For the whole of this distance admirable sections are given by the river and its feeders, the rock being perhaps best shown in Abbey Brook, which gives the following section.

Section of the Yoredale Grit given by Abbey Brook.

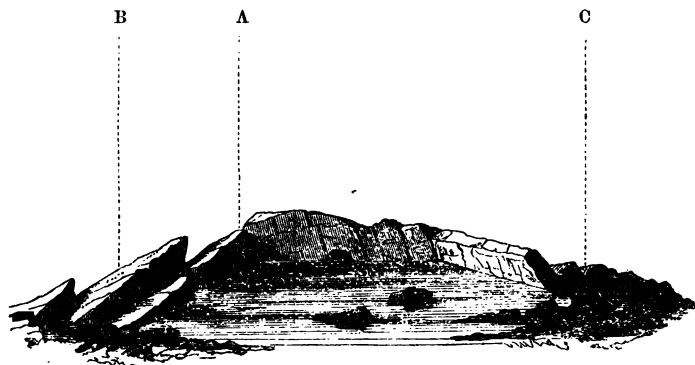
		Approximate thickness in feet.
Shales, 1a.	Grey sandy shale with tilestone in the lower part.	
	Flaggy sandstone - - -	-
	Coarse massive sandstone and conglomerate } -	100
	Grey sandy shale and tilestone - - -	100
	Flaggy sandstone and shale } -	80
	Bed of coarse conglomerate } -	
Yoredale	Shale, sandstone, and tilestone - - -	20
Grit, 1b.	Massive sandstone, coarse in the lower part - - -	150
	Grey sandy shale and tilestone - - -	80
	Massive sandstone (Berrister's Tor rock) - - -	100
	Shales and thin sandstones - - -	120
	Thick mass of sandstone with scarcely any shale, probably quite - - -	200

Though the number and thickness of the shale beds vary very much from place to place, the general character of the rock is everywhere pretty much the same, and is sufficiently shown by the above section. We must, however, call attention to the excessively disturbed state of the beds along this part of the Derwent valley. We find contortions here and there in the upper part of the river, one of which is figured in Fig. 16, and is as odd a piece of bedding as could well be found anywhere. Between B and A the dip is N.W. from 10° to 20°; at A the strike changes through a right angle almost all at once, and the beds dip E.N.E. at 70°, the angle lessening rapidly to the north-east; at C the strike gradually changes to N. and S. and the dip becomes more gentle.

* The following fossils from these beds have been determined by Mr. Etheridge: *Posidonia Gibsoni*, *Goniatites Listeri*, *G. reticulatus*, *G. striatus*, *G. sphacricus*.

Above the junction of the Westend river, however, the beds are not much disturbed, but from that point to Derwent Hall they are violently bent and folded into a number of very sharp anticlinals, which run sometimes a little west and sometimes a little east of north and south. Now it will be recollected that on the other side of the great anticlinal the beds were bent over with a sharp

Fig. 16.
Contorted Beds in the River Derwent.



and sudden change towards the western dip, and along this line we had a belt of faulted ground (p. 46). Here in like manner we meet with disturbances along the line where the easterly dip comes on; but here, perhaps because the change of dip is much more gradual than on the other side, the strain has not been so great and has been able to do no more than bend and fold the rocks into sharp anticlinals, without going so far as actually to break and fault them.

A fault, of which we shall learn more by-and-by, crosses at Derwent Hall, and throws the beds into extraordinary confusion. Another fault crosses about half a mile lower down, and between these faults the rock is as it were pinched up and squeezed into several sharp anticlinal folds, whose axes range approximately parallel to the faults.

The river flows over the Yoredale Grit till below Yorkshire Bridge, when it cuts down to an underlying mass of black shale, most likely brought up by a small fault.

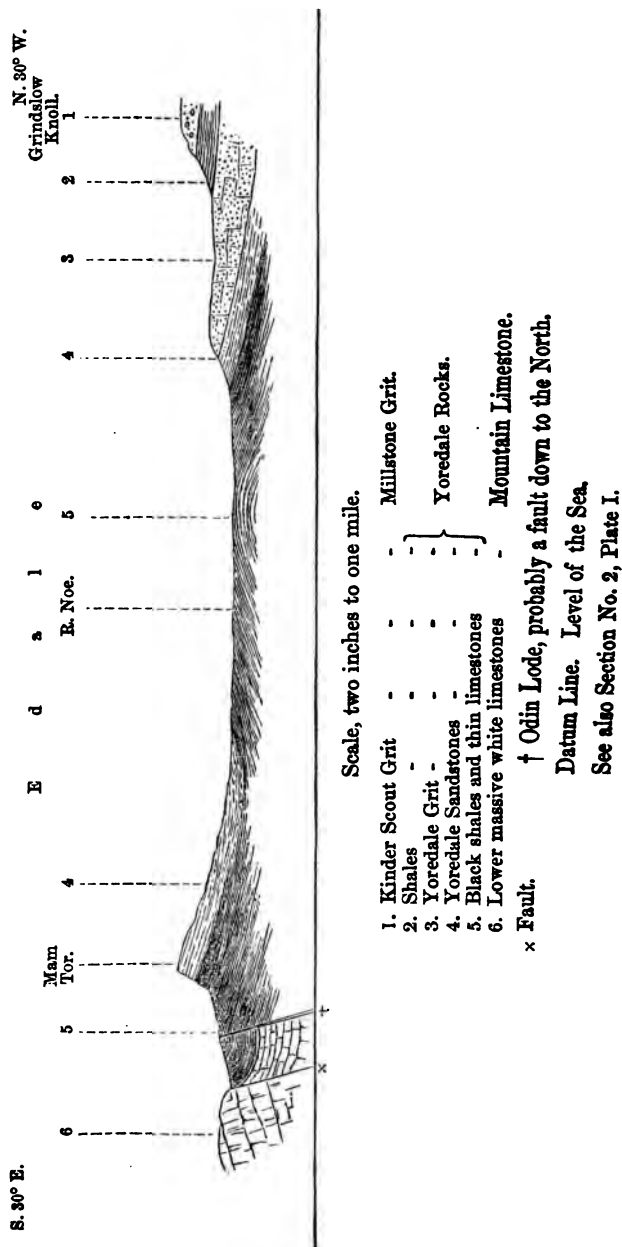
We will now pass to the south side of the Peak. Here the base of the Yoredale Grit is found running roughly along the ridge from Lords Seat by Mam Tor to Lose Hill, and this line may be looked upon as the southern boundary of the plateau of that rock which we have spoken of as surrounding The Peak, for beyond it the rise is steadily to the south, and lower and lower beds come out till at Castleton we find ourselves on the Mountain Limestone. Instead of having, however, an unbroken spread of Yoredale Grit, as was the case on the north, this southern plateau has been cut into and in great part carried away by denudation, and along the middle of it runs a broad and deep hollow, the rich valley of Edale, the geology of which we will now notice.

An anticlinal line ranges along the north flank of the valley, and on the north side of it the greater part of the Yoredale group is brought out to-day by the southerly rise of the beds, and is well shewn in sections which have been already described. On the south of the anticlinal line there are few sections except along the river Noe.

About at right angles to this anticlinal is another running nearly through Edale Chapel and Mam Tor: by this a dome-shaped mass of beds belonging to the lowest Yoredale division is brought up in the

middle of the valley, and the Yoredale Sandstones of Mam Tor are raised nearly as high as the Yoredale Grit of Lord's Seat on the one side, and higher than that of Lose Hill on the other side: the line produced also

Fig. 17.
Section across Edale and the Castleton Valley.



runs through the middle of the Limestone district, and if we could pick out any single line as marking the direction of the great Penine upheaval, this would be the one.

The section along the river Noe shows very clearly the existence of the latter anticlinal. From the base of the Yoredale Grit till about a quarter of a mile below Edale Head House we find thinly bedded, finely grained, hard sandstones, with shales. These are the supposed representatives of the Yoredale Sandstones; at first they dip steadily W. of N. at about 10° , but lower down are very much broken by rolls and anticlinals. From below these beds the black shales and limestones of the bottom Yoredale group come out, and the river continues to flow over them till about a quarter of a mile below Edale Mill, when they are carried below the Yoredale Sandstones by an easterly dip. The beds all along are constantly rolling, and there is not room on the map to put in dips enough to give any idea of their disturbed state; still, upon the whole, they form a flat dome dipping away in every direction from the middle of the valley. The limestone nodules contain *Goniatites* in plenty and other fossils.* The river having entered the Yoredale sandstones, as we have just mentioned, flows over them till it joins the Derwent at Mytham Bridge, though here and there the lowest group is brought out by rolls or small faults. From the bend at Edale End to Hope the beds are violently contorted, so that we find here also, as on the section given by the river Derwent, the beds crumpled and broken along the line where they begin to bend over to the eastern dip (see p. 49).

Over a great part of the middle of Edale are large spreads of superficial wash and gravel, in places as much as 20 feet thick and a quarter of a mile broad. Much of the debris is angular, but there are many rounded pebbles among it, and here and there patches of bedded gravel and sand. The latter, which are in all likelihood true river deposits, are, however, few and small; and though they may well be the remnants of much larger accumulations which were formed when the streams were deepening the valley, they are so much mixed up with later rainwash that it would not be fair to map them as true river gravels. When well covered by vegetable soil these deposits make excellent land.

The valley of Edale is bounded on the south by a ridge running from Lord's Seat (1,816 feet above the sea) by Mam Tor (1,709) to Lose Hill (1,572). This ridge is capped at either end by Yoredale Grit, while the north and south anticlinal already mentioned raises in the middle of it the underlying Yoredale Sandstones to the level of its top.

The latter are well shown in the scarped face of Mam Tor, and between 200 and 300 feet of them are there seen. The bottom of the cliff consists of beds belonging to the lowest division of the Yoredale rocks, and these are found down to the stream just below the entrance to the Blue John Mine, where they rear up on end, and are faulted against the Mountain Limestone (Fig. 17, page 50).

The capping of Yoredale Grit on the eastern part of the ridge seems to be bounded by a fault at its western end. A very fine section of the rock is given by the cliff of Back Tor, where a landslip has detached a large mass of rock on the north side of the hill, leaving a clean cut, vertical cliff, below which heaps of tumbled and broken rock strew the hillside in wild confusion.

Descending the south side of the ridge just described into the broad valley of Castleton, we cross a belt of Yoredale Sandstones, nowhere well seen, and reach the beds of the lowest Yoredale group, in which there are a few sections. The valley is bounded on the south by the Mountain Limestone, which comes out with a steep dip from beneath the Yoredale shales, but soon flattens and stretches far away into Derbyshire (see section No. 2, plate I.)

* The following have been determined by Mr. Etheridge: Scales of *Palæoniscus*, *Goniatites Listeri*, *G. reticulatus*.

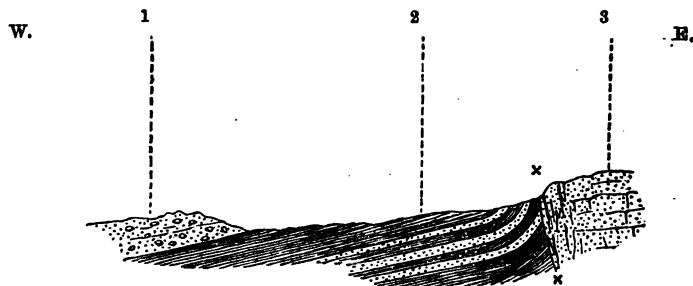
(3.) *The Outcrops of the Kinder Scout Grit on the West and North.*

The first of these lines forms a well-marked ridge running from Glossop nearly to Chapel-en-le-Frith. In passing along it we shall find the rock to become rapidly thinner and finer in grain to the south.

From a fault ranging along Glossop Dale the rock makes a good escarpment till it abuts, on Middle Moor, against a fault which we will call the Sallow Clough fault. The base is shown in the brook at Gnat Hole,* where there is a sandstone bed in the underlying shales a little below the Grit. The rock itself, though on the whole coarse and massive, begins to show traces of the change which is more fully developed to the south. In the quarries south-east of Whitfield it is in parts a closely grained sandstone, yielding a beautiful building stone, and in parts very micaceous, splitting into excellent flags; there are also dark, sandy, micaceous shales interbedded with it.

The Sallow Clough fault may be seen in the brook above Gnat Hole, where it seems to have nearly died out; but it is best shown in the stream after which we have named it, which gives the section sketched below.

Fig. 18.
Section in Sallow Clough.



1. Kinder Scout Grit.
2. Shale with thin beds of sandstone.
3. Yoredale Grit.
- x Fault.

It is worth notice that the fault fades very slightly to the *upthrow side*. The shales are bent sharply up, and the sandstone is shattered by many vertical cracks near the break. The rock most likely broke off along a joint, and this has given the direction to the hade.

A little to the south this fault brings the Kinder Scout Grit against the Yoredale Grit, and the two may be seen lying side by side at the north end of Old Pit Plantation. The fault is again well shown in the brook a quarter of a mile farther on.

The mapping of the beds in the valley of the Hayfield brook, near the Kinder Print Works, is, it must be allowed, very doubtful; but we made the best we could of an uncertain bit. Southwards of this point, however, the two beds of Kinder Scout Grit run on with clear escarpments up to a fault through South Head. The rock is still coarse and massive, but here and there, as about Chinley Head and Mainstone, mixed with flags. Between South Head, however, and Chapel-en-le-Frith the rock undergoes a very sudden and striking change. The upper bed can be easily traced for the whole way, but east of the farmhouse Courses it makes a feeble escarpment, has lessened very considerably in thickness, and, though in parts a conglomerate, is much mixed up with fine sandstone; a section in the cutting of the Midland Railway seemed to show that it is here split into two by a thick bed of shale.

The lower bed is a thick and massive gritstone on South Head, and may be followed without any trouble as far as The Hull; after this we have only a

* In Map 81 N.W.

faint feature to guide us, and, if we may judge by this, the bed must have come down very much both in character and thickness.

At Andrew Rocks there are some fine landslips in this bed.

In the shales between the two Kinder Grits good tilestones are found hereabouts: they have been worked at Bradshaw Field and Mainstones.

The ridges formed by the outcrop of the Kinder Scout Grits are stopped off, as if by a fault, a little to the north of Chapel-en-le-Frith, and the line along which they end, when produced, runs up to some vertical beds hard by Bowden Head, and thence to a point in the brook a little N.N.E. of Ford Hall, where the beds rear up at an angle of 80°. Along this line then a fault, which we will call the Chapel fault, has been drawn.

To the south of Chapel-en-le-Frith lies the flat-topped hill Combs Moss, an account of which will be found on p. 61 of the memoir on the adjoining map 81 N.W.

We will now return to Glossop, and trace the escarpment of the Kinder Scout Grit eastwards from that town.

The fault already mentioned, ranging along Glossop Dale, is nowhere seen, but the way in which the base of the grit is shifted clearly proves that there is some throw along this valley. The rock reappears on Shire Hill, where it is quarried, and is of very much the same nature as at Whitfield (see p. 52). There are old quarries, too, on Cock Hill,* which seem to have been worked for the flagstone interbedded with the grit.

Hence eastward, as far as Barrow Stones,* the rock makes so clear an escarpment as to call for no particular notice. From the plateau of the Yoredale Grit a range of hills, formed of the overlying shales, rises, sometimes steeply, and sometimes with a gentle slope, and is crowned at the top with a line of weatherworn crags of gritstone. The rock is often a conglomerate, as at the Dog Rock,* where the pebbles are as large as beans. On Shelf Moor* are many rocks worn into fantastic shapes by the weather; the upper beds are very coarse and massive, one bed at least 40 feet thick was seen, but towards the bottom there are sandy shales interbedded with the grit. The following section, shown in a brook running from near Hern Stones* to Shelf Barn, will give some notion of the composition of the rock.

Lower Kinder Scout Grit.	{	Thick mass of coarse grit.
		Bed of conglomerate.
		Thick mass of very coarse grit.
		Grit, some coarse, some only moderately so, with grains about the size of wheat.
		Flaggy fine grit, grains about the size of mustard seed.
		Moderately coarse grit, grains from size of wheat to a pea.
		Coarse grit.
		Conglomerate, some grains as big as a bean, and pebbles as big as a walnut.
		Coarse, and more finely-grained, flaggy grit, mixed.
		Underlying Yoredale shales and sandstones.

At Barrow Stones* the grit is thrown down to the north by a fault, and is found again in the river Derwent, near its source, and hence it may be traced along a magnificent escarpment, till it is again shifted by a fault a little to the N.W. of Margery Stones.*

Hence the line bends round and runs due south along Howden Edge, at the southern end of which it again abuts against a large fault.

This fault is nowhere seen, but the evidence for it is beyond question, and is as follows. The underlying Yoredale Grit, which is well shown in Abbey Brook, is made up of thick sandstone beds parted by shales: each of these sandstones may be traced across the country by the feature which it makes, and, when traced, each one is found in turn to run up and abut against the Kinder Scout Grit along a line which ranges east and west through the southern end of

* In Map 88 S.E.

Howden Edge; this, then, must be the line of the fault. The clearest instance is that of the massive sandstone forming the crags of Berrister's Tor, which lies low down in the Yoredale Grit, far below the base of the Kinder Scout bed; when traced out, however, it is found to strike against beds some little way up in the latter, and this nothing but a fault can account for. To the west this fault seems to pass into a sharp anticlinal, shown in the River Westend, just above its junction with the Derwent. A very fine section of the Kinder Scout Grit is given by the brook running down Sandhill Clough;* its excessive coarseness and wild rugged character are very striking, and it is interesting to note how they have given a like stamp to the scenery around.

These two lines, the outcrops of the Kinder Scout Grit on the west and north, we have traced here because they form the boundaries on those sides of the country we shall have to describe; the remainder of the country occupied by this rock will be taken in hand further on.

It will be convenient to notice here the sections given by the brooks which flow southwards from the ridge formed by the northern escarpment of the Kinder Scout Grit.

In the hollow called Lower Shelf on the map it is quite impossible to say what shall be called the top of the Yoredale Grit, so intimately are shales and sandstones mixed up together for a long way below the base of the Kinder Grit.

Shelf Brook itself gives good sections in beds almost wholly sandstone and grit, and in some of its feeders we get what may pass for lines of division between the Yoredale Grit and the overlying shales; the clearest section was given by a slip north-west of the "S," in the words "Shelf Brook," it showed

	ft.	in.
1. Sandy shales with thin beds and concretions of sandstone	- 35	0
2. Grit and sandstone with thin shale partings	- 35	0
3. Sandy shale with thin beds and concretions of sandstone	- 10	0
4. Shale	- 8	0
5. Sandstone with shale partings	- 7	0
6. Shale with concretions and thin white sandstones	- 25	0

Here one would be puzzled to say what was to be called shale and what Yoredale Grit. We agreed to draw the line at the top of the well-marked sandstone No. 2, and this will give us only 50 feet or thereabouts of shale between the Kinder and Yoredale Grits.

In the upper part of Shelf Brook, called Crooked Clough on the map, there was a fairly marked change from sandstone to a thick mass of shale, and here again we drew the line; but if the whole of the beds from here up to the base of the Kinder Grit be shale, the dividing band will be about 300 feet thick.

In Hern Clough we have the following section:

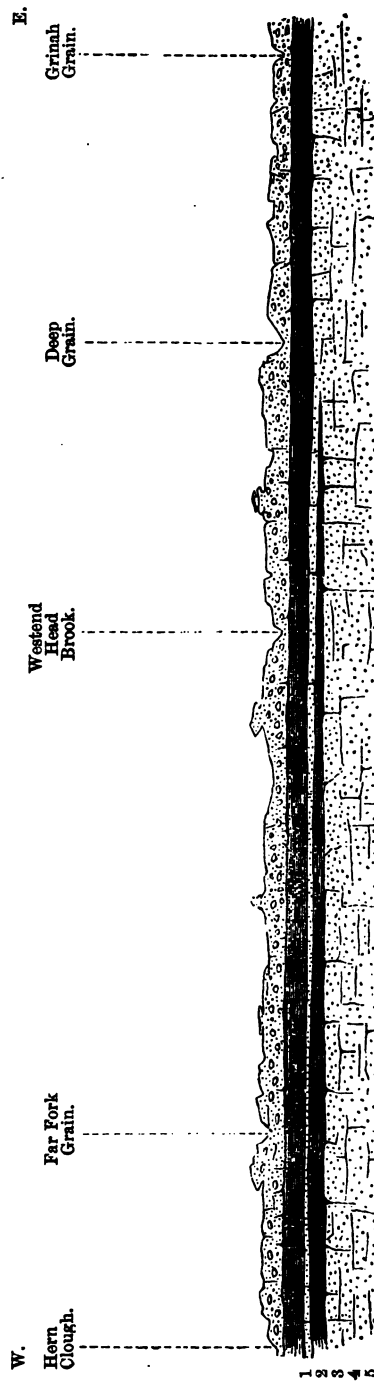
1. Kinder Scout Grit.
2. Sandy shale with beds of clayey sandstone, about 200 feet.
3. Hard coarse sandstone, 30 to 40 feet.
4. Dark and grey shale, about 100 feet.
5. Massive sandstone, often very coarse, with thick shale partings.

Looking at this section alone, it is puzzling to say whether the top of the Yoredale Grit had better be drawn between (2) and (3) or between (4) and (5); in one case we put a thick mass of shale into the grit, in the other we put a good sandstone bed into the shales. When traced across the country, however, (3) and (4) are found to be very changeable; in Far Fork Grain* (3) has nearly died away, but it sets in again before Westend Head,* for in the brook there we have the same section as in Hern Clough;* but in Deep Grain* and Grinah Grain* (4) is completely replaced by sandstone. We have, therefore, drawn the line at the top of (3). The diagram opposite (Fig. 19) shows these changes.

The shales beneath the Kinder Grit are well shown in a gully north of Round Hill* in Hoar Clough,* where they are about 325 feet thick, and in Steiner Clough,* where they are about 400 feet thick.

* In Map 88 S.E.

Fig. 19.
Diagram of the Beds between Hern Clough and Grinah Grain.



The numbers refer to the section in Hern Clough on the last page. Length of diagram, about $2\frac{1}{2}$ miles.

Having now described, as fully as the materials in our hands would allow, the country on the crest of the great anticlinal, we will next pass to the belt of land running southwards from Bradfield, along which the easterly dip comes on, and the Millstone Grit beds crop out with a gentle rise from beneath the Coal-field of Yorkshire and Derbyshire. And we first take in hand the following tract.

- (4.) *The Bradfield Basin, or the country bounded by the Bar Dyke fault on the north, the Agden fault on the south-west, and the Onesmoor fault on the east.*

The first of these faults runs nearly east and west a little to the south of Bar Dyke, with a down throw to the south. It is nowhere seen, but when we find the outcrops of the several beds of Millstone Grit running up and ending off in turn against a broad spread of sandstone and shale believed to be Yoredale Grit, it must be that the line along which this change takes place is a line of fault. A glance at the map will show that this is the case along the line marked as the Bar Dyke fault.

The Agden fault runs a little to the south of Bradfield * with an average north-westerly and south-easterly trend. This is one of those lines of disturbance so clearly pointed out by the shape and features of the country that the first glance is enough to enable one to detect it. Standing upon Ughill Moors one sees to the west the outcrops of the two Kinder Grits and the Third Grit running in well-marked ridges in a direction east of north up to the valley of the Agden Brook, which they do not cross, but end off suddenly on reaching its southern bank, while on the opposite side of the valley a fresh group of escarpments sets in having a direction nearly at right angles to those on the south side. This evidence, satisfactory enough in itself, is confirmed by sections that will be described below.

The evidence for the north and south fault running across Onesmoor * is somewhat slender in the southern part of the country we are now looking at, as it there only brings one Coal-measure sandstone against another; but there is good reason to think that the rock on the east side is higher in the series than that on the west side, and that therefore some fault must run across the moor, though there must be much doubt about its exact place, because the look alone of the two sandstones will not enable us to tell one from the other. On Bent Hill,* however, the Rough Rock is certainly faulted against a Coal-measure sandstone, and further to the north, in country which will be described in a future memoir, a mass of sandstones and shales, which there is good reason to think are of Yoredale age, is thrown by a fault having the same line against beds which are certainly Coal measures.

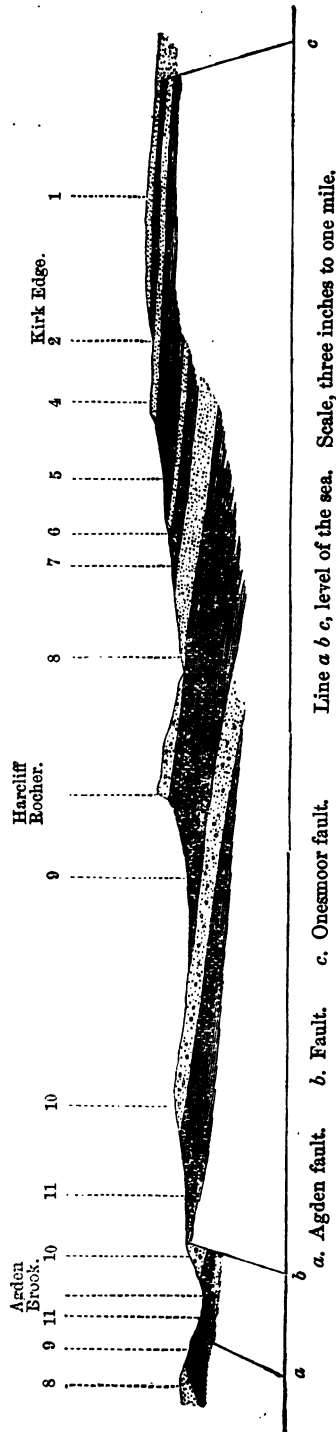
In the triangular area bounded by these three faults we have the group of beds shown, with their estimated thickness, in the following table, and on the section Fig. 20, opposite.

General Section of the Measures in the Bradfield Basin.

	ft.	in.	
1. Sandstone - - - -	-	0	Lower Coal Measures.
2. Shales - - - -	50	0	
3. Fireclay - - - -	2	6	
4. Rough Rock - - - -	70	0	
5. Shales - - - -	175	0	Millstone Grit.
6. Second Grit - - - -	25 to 40		
7. Shales - - - -	55	0	
8. Third Grit - - - -	170	0	
9. Shales, with a thin Ganister Coal	250 to 350		
10. Upper Kinder Scout Grit	100 to 200		
11. Shales and Tilestones - - -	-	-	

* In Map 82 N.W.

Fig. 20.
Section across the country north of Bradfield.



On the west the outcrops of the Upper Kinder Scout, Third, and Second Grits run across the country in parallel lines, ranging north-west and south-east, and abut against the Bar Dyke fault on the north and the Agden fault on the south. To the east of these is an outlier of Lower Coal-measures, fringed with an edging of Rough Rock, somewhat of a horseshoe shape, with its ends resting against the Onesmoor fault and a branch of the Agden fault. The Kinder Scout Grit and the Rough Rock have their usual characters, the Third Grit is a massive but finely grained sandstone, the Second Grit is feebly represented. The only noticeable feature in the small part of the Lower Coal Measures seen in the district is a bed of valuable fireclay lying on the top of the Rough Rock.

Starting at the north-west corner we find the Agden fault running along one side of the valley, and a loop fault, marked (b) in Fig. 20, on the other, the space between being occupied by two outliers of coarse massive grit underlaid by dark shales and tilestone; and there does not seem to be any way of explaining the lie of these grit masses except by means of such a loop fault as we have drawn. It is impossible to say for certain which bed of the Millstone Grit these outliers belong to, but in look they are like Kinder Scout Grit, and the underlying beds are such as are often found between the two Kinder Grits.

Again a fault which may be called the Bradfield fault branches from the Agden fault and runs a little south of east near Bradfield* Church and the Castle Hill.* The space between this and the Bar Dyke fault is striped across by the outcrops of the several grit beds with great regularity, the dip being easterly at about 6° .

The Upper Kinder Grit, which if our estimate is trustworthy is here unusually thin, is a coarse massive grit with beds of flaggy sandstone in the upper part. Its line begins at Smallfield, where it was seen, in a cutting beside the Agden

* In Map 82 N.W.

Reservoir, to be thrown against the Second Grit by the Agden fault. The ending off of the escarpment against the Bar Dyke fault on the north is not so clear as could be wished, but there seems to be a very sudden change from the gritstone to sandy shale and sandstone, which nothing but a fault can explain.

The thin coal mentioned in the shales between the Kinder and Third Grits was shown in the following section, in the brook, S.E. of Rocher End.

	ft.
Shale and sandy shale - - -	7
Coal and a little shaly coal - - -	1
Ganister, about - - -	6
Sandy shale - - -	9

There is little if any coarse rock in the Third Grit here, the bed being from top to bottom a finely grained sandstone, in thick beds which split up when weathered into flags. The rock, however, has the long straight joints which we have already spoken of as so characteristic of this bed, and in consequence its escarpment shows here and there a bare vertical face of rock, as in the fine cliff above Harcliff Rocher. The ridge formed by this rock ends off in a very marked way against the Bar Dyke fault on the north.

The only representative of the Second Grit is a miserable sandstone, about 25 feet thick, barely traceable.

The outcrop of the Rough Rock may be clearly traced from the Onesmoor fault at Bent Hill,* round West Nab,* and along Kirk Edge,* till it abuts against the Bradfield fault near Kirk Edge House.* It is there thrown down and breaks out again at the Castle Hill,* and this shifting is the chief evidence we have for the Bradfield fault.

We believe the above to be the most likely identification of the gritstone beds just described. About the Rough Rock we have no doubt; it is, however, possible that the thin sandstone and the Harcliff Rocher rock with the shales between (Nos. 6, 7, 8) may be the equivalents of the Second Grit, and then No. 10 will be the Third Grit. It is in favour of this view that immediately on the other side of the Agden fault the Second Grit is a thick mass of sandstone in two or three beds with shale between, and on our first supposition the change in thickness on crossing the fault is very sudden. On the other hand, an intimate acquaintance with the Second Grit prepares us for any amount of change whatever in this variable bed, and the Harcliff Rocher rock is remarkably like the Third Grit in its jointing.

On the top of the Rough Rock is a bed of fireclay worked at a pottery on Kirk Edge, where we found the following section.

Section at Kirk Edge Pottery.

	ft. in.	ft. in.
Shale with <i>Goniatites</i> , <i>Aviculopecten papyraceus</i> , <i>Posidonia</i> - - -	5	0
Shale with a little carbonaceous matter - - -	0	4
Bright coal, about - - -	0	1
Stiff fireclay, "Pot clay," from - - -	2	6 to 2 10
Soft sandstone, ground up with the clay when it is used for making firebricks - - -	1	6

The manager of the works told us that the clay got much harder when followed into the hill, and that a man who could get three tons a day at the outcrop would not get more than half a ton when working 200 yards in on the dip. The dip here is E. 30° N., at about 4°.

Above the Rough Rock come about 60 feet of shales, and then the lowest sandstone of the Lower Coal Measures, for which we propose the name of Crawshaw Sandstone.

In the angle between the Bradfield and the Agden faults we find the Third Grit on Oaking Bank, a feeble ridge supposed to be made by the Second Grit, a bold escarpment of the Rough Rock running from the Castle Hill* to near Peck Hall,* and lastly the Crawshaw Sandstone on Holdworth Bank.* The latter seems to be cut off on the east by a fault which was well seen in a brook 21 chains south of Holdworth Hall.*

The line of the Agden fault is well given, for the Rough Rock opposite Peck

* In Map 82 N.W.

Hall* abuts suddenly against a sandstone which when traced out proves to be the sandstone next below the Ganister Coal: thus we get one point. Also the escarpment of this sandstone runs on close below that of the Crawshaw Sandstone on Holdsworth Bank,* though between the two sandstones there are some 500 feet of measures: hence it is evident that a large fault must come between, and the Agden fault has been drawn accordingly.

(5.) *The Crawshaw Basin, or the country between the Agden fault on the North, the Moscar fault and Rivelin valley on the South, and the Dungworth fault on the East.*

The Moscar fault runs from Derwent Hall, where it brings about great disturbance, already noticed, of the rocks in the bed of the river, across Derwent Edge, near the Wheel Stones, shifting in a very marked way the outcrop of the Kinder Scout Grit; by the south end of Strine's Edge, where the ridge formed by the Third Grit ends off; by Moscar Flat, cutting off in like manner the ridges of the Second Grit; and thence ranges along the upper part of the Rivelin valley to about Oaking Clough. Hence eastward the fault seems to pass into an anti-clinal ranging down the valley. (See p. 67).

The Dungworth* fault has been proved in the workings of the Ganister Coal near that village: it stops off the escarpment of the Rough Rock east of Hall Broom;* brings at Rickett Field* the Second Grit against the sandstone below the Ganister Coal, and hence seems to range up to a point in the brook a little below Low Bradfield,* where a fault was shown. The course of this fault southwards from Dungworth will be noticed below (p. 71).

Across the western part of the country bounded by these faults the outcrops of the four lowest grits run in nearly parallel belts, bearing east of north, and end off against the Agden fault on the north and the Moscar fault on the south. The escarpment of the Rough Rock is in the shape of a horseshoe, the two ends abutting against the Dungworth fault, and in the middle is an outlier of Lower Coal Measures.

The following section of the measures on the western part of the district is taken from Horizontal Section, Sheet 69, of the Geological Survey.

General Section of the Measures in the Western part of the Crawshaw Basin.

		ft.	in.	ft.	in.
Lower Coal Measures	{ Crawshaw Sandstone at least	- 150	0		
	{ Shales	-	70	0	
	{ Fireclay	-	1	6 to	4 6
	{ Rough Rock	-	25	0 "	80 0
	{ Shales	-	180	0	
Millstone Grit	{ Second Grits and Shales	-	250	0	
	{ Shales	-	230	0	
	{ Third Grit	-	250	0	
	{ Shales with a sandstone bed	-	130	0 to	220 0
	{ Upper Kinder Scout Grit	-	120		
Yoredale Rocks	{ Shales	-	120		
	{ Lower Kinder Scout Grit	-	450		
	{ Shales	-	270	0	
	{ Yoredale Grit.	-			

* In Map 82 N.W.

The measures undergo very marked and sudden changes as we pass to the eastern part of the district: from shafts sunk for a tunnel of the Sheffield Waterworks, and from other sections, the following account of them in that direction is drawn up.*

*General Section of the Measures in the Eastern part of the
Crawshaw Basin.*

		ft.	in.	ft.	in.
Lower Coal Measures.	Crawshaw Sandstone.				
	Shales	-	-	70	0
	Fireclay	-	-	1	6 to 4 6
	Rough Rock	-	-	75	0
	Shales	-	-	70	0
Millstone Grit.	Second Grit	-	-	24	0
	Shales	-	-	75	0
	Third Grit	-	-	170	0
	Shales with Ganister and Sandstone	-	-	550	0
	Upper Kinder Scout Grit.				

The two Kinder Scout Grits are seen here in their full developement. The Third Grit passes from a sandstone, often flaggy, with perhaps an upper portion of coarser rock, into a hard thickly-bedded gritstone, not very coarse. The Second Grit reaches an unusual thickness here and there, and shows very extraordinary changes. The Rough Rock, with one very local exception, where it puts on the form of a finely grained flagstone, keeps its usual character. The Lower Coal-measures contain the same bed of fireclay as in the last district.

It will be remembered that we left the base of the Lower Kinder Scout Grit where it abutted against a fault at the south end of Howden Edge (see p. 53). The underlying shales are again found in the upper part of Cartledge Clough, but the exact place of the base of the grit is here doubtful. From Carter Stones Ridge, however, along Derwent Edge we get a magnificent escarpment crowned with many strangely shaped piles of rock, and mostly ending in a cliff of gritstone below which is a steep slope of the underlying shale.

The band of shale between the two Kinder Grits runs from the Agden fault round the base of Flint Hill,† and the junction with the Lower Grit is well shown in Flint Dyke, which flows for some way on the top of this bed. The upper beds of the gritstone are fine and flaggy, and there is a coal about two inches thick a little way up in the shale. If we now follow Flint Dyke till we reach the Agden Brook, we shall find a fault crossing a little below the junction. This fault, which is shown in a cliff by the brook side, seems to throw down the Lower Kinder Grit to the east, so that beyond the fault we have only a narrow tongue of that rock running along the bottom of the valley; a little further down the grit is carried out of sight by an easterly dip, and the brook cuts into the overlying shales, which are well shown in a cliff. Hence the base of the Upper Kinder Grit is marked by a clear escarpment, but we get no evidence for the top of the Lower Kinder till the north-west corner of Hollindale Plantation, where the junction was seen in a stream. In the next brook to the south it looks very much as if the shale band between the two Kinder Grits had thinned out altogether; all we can say is, that there is a narrow space showing no section, which may be shale; but even in this case the band must be far thinner than it is in sections both on the north and south close by. However, in Foulstone Dyke we again get a clear section showing about 140 feet of shale mixed with flaggy sandstone, the top of the Lower Kinder

* See also Horizontal Section of the Geological Survey, Sheet 69, which crosses this district and will explain its structure.

† In Map 88 S.E.

being fairly marked and the base of the Upper Kinder very clearly shown. Both boundaries of the shale are shown in Blackhole Clough, and it seems there to be about 200 feet thick and sandy.

The Upper Kinder Grit has at its base beds of flagstone; above comes very coarse and massive grit forming the greater part of the bed, and again at the top we often find some flaggy sandstone. The lower flagstone is worked at Foulstone Delph and may be seen in the Blackhole brook, which likewise gives a good section of the whole bed; and the uppermost beds will be found along Strines Dyke, which runs for some way on the top of the grit.

Our attempts to determine the thickness of the Kinder Scout Grit in this district have led to very contradictory results. But whether this is owing to the rocks being really very variable in thickness, or whether the observed dips are not enough to enable us to plot our sections with accuracy, we cannot say; in the following table are the results given by five sections.

	(1)	(2)	(3)	(4)	(5)
Third Grit - - - -	—	260	—	—	250
Shales - - - -	130	220	220	220	220
Upper Kinder Scout Grit - -	100	175	300	250	120
Shales - - - -	80	150	—	200	120
Lower Kinder Scout Grit - -	300	{ between 300 and 500 }	—	500	450

The first four of these were plotted from the Ordnance six-inch maps, and the fifth is taken from Horizontal Section, sheet 69, of the Geological Survey.

Upon the top of the Upper Kinder Grit there are traces of very thin beds of coal, and above shales with at least one noteworthy sandstone. The shales and sandstone are well shown in the upper part of Emlin Clough and seem there to be about 130 feet thick. The following section was seen at the junction.

	ft. in.	ft. in.
Shale, <i>Goniatites</i> , <i>Aviculopecten papyraceus</i> , <i>Posidonia</i> .		
Coal and shaly coal, $\frac{1}{8}$ th to $\frac{1}{4}$ inch.		
Under clay - - - -	1 6	
Sandy shale - - - -	7 0 to 9 0	
Grit, upper surface waterworn.		

The same measures are again well shown in Hollingdale Brook and the cliff on its eastern bank, where they are again about 130 feet thick. The following section was seen at one spot.

Shale - - - -	60·0
Coal - - - -	0·0 $\frac{1}{2}$
Sandy fireclay - - - -	2·9
Sandstone slightly micaceous, top of Kinder Scout Grit	2·6 seen.

In the roof the coal were indistinct plants, and a foot or two up in the shale, *Goniatites*, *Aviculopecten papyraceus*, and *Posidonia*. In another section the fireclay was four feet thick, with from half to three-quarters of an inch of pyritous coal on it, and occasional bands of coal about one-eighth of an inch thick in the shales above. The top of the Upper Kinder Grit was laid bare in the brook above Strines Bridge and was most distinctly waterworn; the little coal was also seen here, and black shale with the usual fossils above. Again, we get admirable sections of these beds along Strines Dyke, they are here about 220 feet thick and have a bed of flaggy sandstone in them near the top. At Raddlepit Rushes was the following section.

Black Shale with plants, <i>Goniatites</i> , <i>Aviculopecten papyraceus</i> .	
Hard stony bind - - - -	0·6
Coal - - - -	0·1
Light grey fireclay.	

The grit was not actually seen, but must have been close below.

The two brooks just mentioned, Strines Dyke and Holling Dale Brook, both flow in great measure on the top of the Upper Kinder Grit, which forms the slightly sloping western side of the valley, while the eastern bank is a steep cliff of shale which the rain and frost are ever working at, the stream carrying away the debris, and itself bearing its share in the work of destruction by undermining the bank, and the valley is thus being gradually widened. We have already noticed how common this relation between the shape of the ground and the lie of the rocks is, and we could perhaps nowhere find a better instance than the one before us.

The Third Grit has here its typical form, coarse grit in the upper part and flaggy sandstone below; the lower division seems to be the thicker of the two, and perhaps here and there the upper coarse part may be altogether wanting. On Emlin Hill the base is flaggy sandstone, but the upper portion of the bed is coarse grit, shown in the lower part of Emlin Clough. The outcrop of the flagstone forms Bole Edge, and the rock has been very largely quarried at Thorseat Hill, where it is mixed with beds of sandy shale; while we find coarse grit along Old Mortimer Road and to the east of it. In Strines Dyke the bed seemed to be finely grained sandstone from top to bottom. On Strines Edge there is a flagstone at the base, and above is a hard closely grained grit; there are here no sections in the topmost part of the bed. Owing to its want of massiveness and the absence of those master joints, which are elsewhere so characteristic of this bed, the rock, though it makes a clear ridge, fails to form here the striking escarpment which we shall see marks its outcrop from Crow Chine southwards for many miles.

The upper boundary of the Third Grit is almost wholly conjectural; at the foot of the Bradfield Reservoir the junction with the overlying shales was seen, and the rock was there much disturbed by sharp rolls. If this be often the case, it is no wonder that the line is hard to trace in the absence of sections, and no wonder that it looks queer on the map.

The beds between the Third Grit and the Rough Rock are in the country we are now looking at most tiresome and bewildering. Starting at the south-east corner we find these measures to consist of shale with a single bed of sandstone, which may be traced, with more or less certainty, from the Dungworth fault east of Flash up to the Surrey Arms. South of Moorwood there were very doubtful traces of old coal workings on the top of this bed. The sandstone was proved in the tunnel of the Sheffield waterworks to be 24 feet thick, and it is here the only representative of the Second Grit. West of the Surrey Arms the bed fails for a while, but we find it again in Moscar Flat, abutting against the Moscar fault on the south. The fault branching from the Moscar fault up towards Hollow Meadows House has been drawn to account for the lie of the rock. A thin coal and fireclay have been worked on the top of the sandstone at Moscar Plantation, but the clay is said to have been of bad quality. The sandstone forms a ridge running up to Moscar Cross, and there, below it, is the escarpment of a second sandstone, the section being about as follows.

(2)

	<i>a.</i> Rough Rock.			ft.
	<i>b.</i> Shales	-	-	180
Second Grit.	1. Flaggy sandstone	-	-	100
	2. Shale	-	-	70
	3. Flaggy sandstone	-	-	60
	<i>c.</i> Black shales	-	-	240
	<i>d.</i> Third Grit.			

We take one of the beds Nos. 1 and 3 to be equivalent of the 24 foot bed we started with, and the other to be a fresh bed, thinning away to the south-east.

We next have a section south-east of Sugworth, where the words "Slate Quarry" are written on the map, which shows that the sandstones are beginning to be split up and mixed with shale. It is as follows.

(3)

a. Rough Rock.	ft.
b. Shales about	100
Coal	1
Underlay and shale	10
Flaggy sandstone	20
Dark shale	50
Second Grit { Flaggy sandstone mixed with shale	
Shale	100
Sandstone and shale	
c. Black shale, parting Second and Third Grits	200

The sandstones make features along their outcrop, but they are very changeable and hard to trace. The coal has been gotten by the "Slate Quarry," and also above Coe House.

Holes Clough and the Bradfield Brook give us the next section.

(4)

a. Rough Rock.	ft.	in.
b. Shales	200	0
Coal	1	6
1. Flaggy sandstone	25	0
2. Shale (?)	50	0
3. Flaggy sandstone	25	0
4. Shale	80	0
5. Ganister with trace of coal above	about 30	0
6. Flaggy sandstone		

Between here and the eastern end of the Bradfield Reservoir two faint features may be traced along the southern flank of the valley which perhaps mark the outcrops of Nos. 1 and 3. Nos. 5 and 6 may be seen here and there in the brook, and were well shown in the reservoir cuttings, which gave the lower part of the following section.

(5)

a. Rough Rock	ft.	in.
b. Shales	90	0
1. Sandstone	160	0
2. Shales	40	0
3. Sandstone	180	0
4. Black shale with very thin seams of coal towards the bottom	40	0
5. { Ganister	110	0
Hard sandstone, in thin wavy beds, with stigmaria	2	0
Hard finely grained sandstone	3	6
6. { Shales and thin sandstones	34	0
Flaggy sandstone, mixed with shale	7	0
c. Black shale, 45 feet seen, whole estimated thickness	17	0
d. Third Grit.	127	0

No. 6 may be followed down to the brook at Walker's House, where we have the following section.

	ft.	in.
Sandy shale	2	0
Bright and shaly coal	0	6
5. { Hard ganister, thickness variable, on an average	2	0
Soft ditto ditto ditto	2	0
6. Sandstone with plants	20	0

Even in this short distance many changes may be noted in it. Shale partings split up the bed for a while, and then thin out again, and its composition is never for many feet exactly the same. Hence the bed runs with a clear escarpment, and it would seem with an increasing thickness, by Woodseats to Windy Bank, where it is thrown down by a small fault; the ganister and coal

were seen at several spots along the line, as in Agden Brook, where we have the following section.

	ft.	in.
Shale, about	20	0
Shaly coal; half shale, half coal	0	1
Ganister	2	0
Sandstone and sandy shale (in one place a little coal in the shale)	20	0

The topmost sandstone No. 1, in section (3) seems to die away a little to the east of the reservoir; but a bed, probably the equivalent of No. 3, but somewhat thicker, is found along the bottom of the valley, runs round by Windy Bank, and is found again in the Agden Reservoir, where it was well laid open and seen to be excessively false bedded; this is the bed already mentioned as brought against the Lower Kinder Grit by the Agden fault at Smallfield. In the shales above this sandstone, a bed of hard carbonaceous shale and shaly coal, about one foot thick, was bared in the Agden Reservoir, and worked by the poor people for mixing with coal. Above comes another flaggy sandstone, seen in a quarry above Low Bradfield; it may be the representative of No. 1, which after dying away for a while has here set in again. The following is an average section of these beds.

	(6)	ft.
1. Sandstone about	-	60 seen.
2. Shales	-	75
3. Sandstone	-	50
4. Shales	-	90
5. Ganister	-	100
6. Sandstone }	-	
c. Shales	-	140
d. Third Grit.		

These sections have been described at length, because they show the great changeableness of the beds between the Rough Rock and Third Grit; to make the matter clearer to the eye, they are plotted to scale in Fig. 21, opposite.

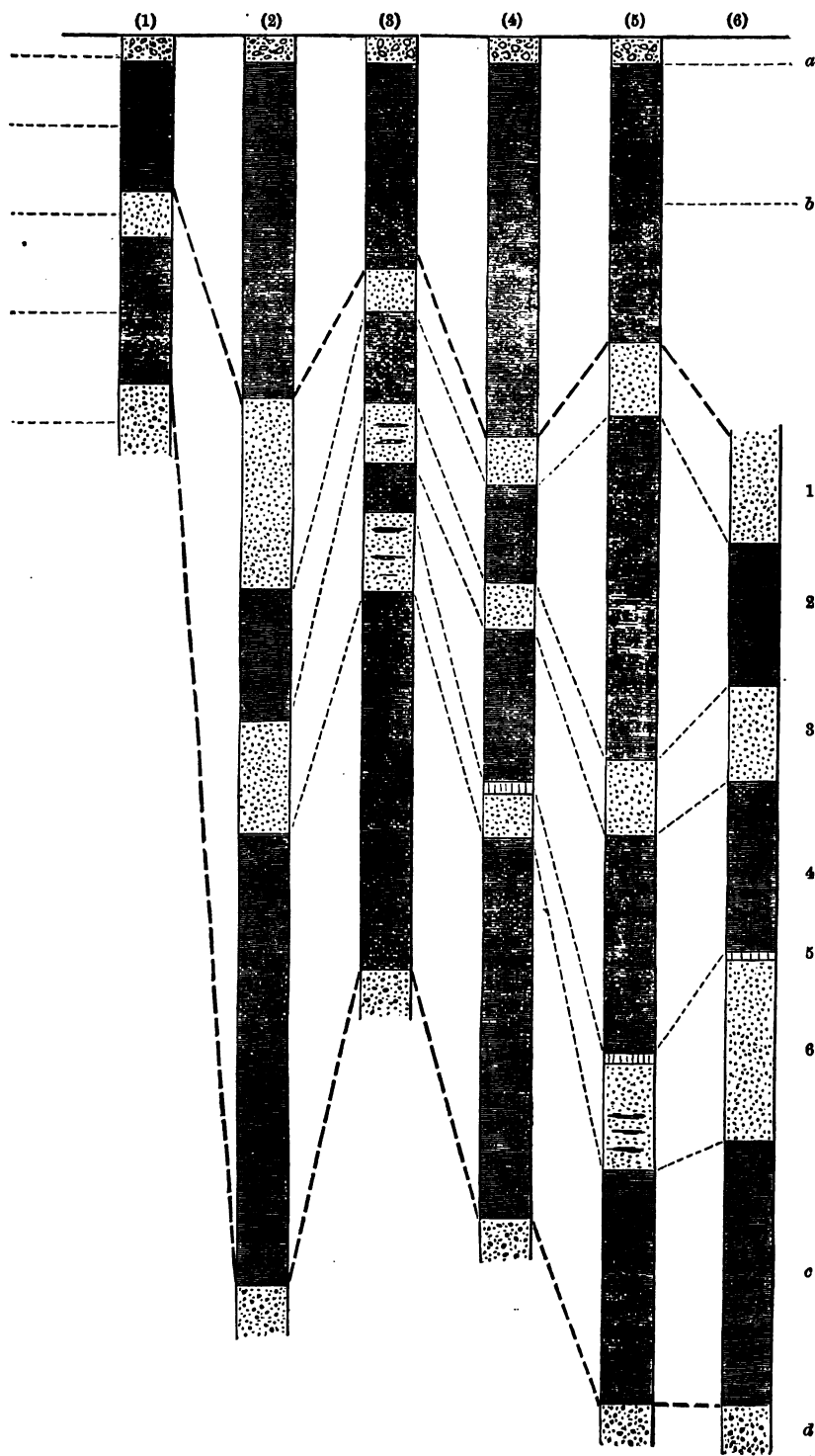
We see now how it is that we cannot in the present country talk of any Second Grit at all; but must say, that in the beds between the First and Third Grits, which themselves vary from 170 to 700 feet, there lies a very changeable mass of sandstone and shale, ranging in thickness from 24 to 440 feet, and that this, or part of it, is most likely the equivalent of the one or two marked sandstone beds, which we elsewhere call the Second Grit.

Lastly, we come to the outlier of Lower Coal Measures fringed by an edging of Rough Rock which lies in the middle of the district we are describing. An average section of the measures is as follows.

	ft.	in.	ft.	in.
1. Coal	1	3 to	1	4
2. Crawshaw sandstone	150	0		
3. Dark shale	75	0		
4. Coal	0	4 to	0	0
5. Fire clay	5	0		
6. Rough rock	25	0 to	90	0

A fault ranges N.W. and S.E. across the basin through Ughill, which we will call the Ughill fault. It is best seen where it shifts the outcrop of the Rough Rock north-west of Edgefield.

The fault running nearly parallel to this and a little to the south of it, can be fixed very closely at Corker Walls, and a little further to the south-east, where it brings the Rough Rock against the Crawshaw sandstone. The throw of the fault at the latter spot is such as to bring the bottom of one sandstone almost exactly on a level with the bottom of the other, and there is consequently no break in the escarpment to point out a fault, but on the ground the sudden change in the character of the rock gives us a trustworthy guide. The fault



No. (1). Section given by the Tunnel of the Sheffield Water Company. Nos. (2) (3) (4) (5) (6). Sections so numbered on pages 62-64.
 a. Rough Rock. b. Shales. c. Shales. d. Third Grit. e. Shales. f. Shales. 1-6. Beds so numbered in sections on pages 62-64.

was also proved in one of the shafts of the Sheffield waterworks tunnel on Gam Lane.

Of the Rough Rock it is chiefly to be noticed that though for the most part it is a coarse, thickly-bedded grit from 70 to 90 feet thick, in the south-east of the district it passes into a finely grained flaggy sandstone, and is sometimes not more than 25 feet thick.

The fireclay No. 5 is black, and can be used either for firebricks or crucibles. In 1864 the best quality fetched in Sheffield 25s. a ton.

The Crawshaw sandstone is for the most part fine and flaggy, but here and there becomes coarse and massive.

There is some little doubt about the coal No. 1, for the workings have been long abandoned, but it seemed to lie close upon the top of the Crawshaw sandstone. It is found only on the downthrow side of the Ughill fault, and the workings for it form part of the evidence by which that fault has been drawn. Over the outlier of Lower Coal Measures lying to the east of the Ughill fault, there is not a single section to give us the dip of the measures; but from the shape of the ground, and the way in which the geological boundary lines run down hill, there is very little doubt that the beds slope gently to the west; and thus, in going from Woodhouse to Upper House, we cross in succession the Rough Rock, the shale band No. 3, the Crawshaw sandstone, the crop of the coal No. 1, and reach the measures overlying that coal: but a little further on in the same direction we find ourselves again on the Crawshaw sandstone, which must have been therefore thrown up by a fault; and as the marshy ground formed by the shales over the coal can readily be distinguished from the dry soil of the sandstone, the line of the fault can be here marked out very closely. The coal No. 1 was found just above Upper House to be from 15 to 16 inches thick, and was thence followed into a plantation by the roadside south of Edgefield. It was found at the east end of the plantation, but not in a shaft sunk at the west end, and the fault has been drawn accordingly between the two spots.

Passing to the west of the Ughill fault, we may notice that on Gibraltar Rocks the Crawshaw sandstone is a coarse, well-jointed, false-bedded grit, more like a Millstone Grit than elsewhere.

The Rough Rock is a coarse massive grit, making a good escarpment almost as far as Bamford Lodge.

The first section seen in the fireclay, No. 5, was at an open work near the south-west end of Hoar Stones Road; it showed

Black shale.*					
Very bad coal	-	-	-	-	0 4
Dark fireclay	-	-	-	-	3 6 seen.

Hence the crop of the clay may be clearly traced by the aid of old workings to the north-east of Bamford Lodge. From here, though the base of the Rough Rock is well given, except for a short distance on the north-west of the lodge, its upper boundary is ill marked. There is little doubt, however, that the rock is growing thinner and more finely grained, and about Hollow Meadows it cannot be more than 25 feet thick, and, though still coarsish, it is far less striking than below the Gibraltar Rocks. In a quarry half a mile west of Morwood it is a thickly bedded, closely grained sandstone, and has pretty much the same character up to that house. Hence eastwards it changes still more, and over the spread of rock round Westfield, and along the tongue which runs up into Load Brook, it is a fine flaggy sandstone which it requires some courage to call Rough Rock. There can, however, be no doubt about the bed being the same all along, especially as the overlying fireclay is again worked in the valley of Load Brook. The section there is

Black shale, with <i>Goniatis</i> , <i>Aviculopecten papyraceus</i> , and (?) <i>Modiola</i> .					
Coal	-	-	-	-	0 1
Grey fireclay, good for crucibles	-	-	-	-	2 0
Hard grey fireclay, good for bricks, about	-	-	-	-	2 6

* The following fossils were found in this Black shale roof: *Anthracosia acuta* A. robusta, var. β ; *Aviculopecten papyraceus*; *Goniatis*; scales of *Palaeoniscus*. A specimen of *Sphenopteris* was found in a shale nodule in the middle of a very coarse bit of Rough Rock.

The clay has been gotten up to the Dungworth fault, and the spot where the workings cease gives a point on the fault.

The Rough Rock again comes out to day, and the clay is worked in an inlier of Millstone Grit, running along the valley of Royds Clough, and bounded by the Ughill fault on the east. A quarter of a mile west of Crawshaw the clay is dark grey, very full of *Stigmara* rootlets, 1 ft. 6 in. on an average, but running up to 4 feet. There is no coal. It is also worked up the valley north-west of Platts. The Rough Rock hereabouts is a grit neither very coarse nor very fine; about Corker Walls it for a while makes a rocky escarpment, but soon sinks into tameness again. The fireclay has been proved south of Rickett Field.

Further down Royds Clough the following measures are shown :—

					ft.
	Rough Rock	-	-	-	85
	Shales	-	-	-	75
Second Grit.	1. Sandstone	-	-	-	25
	2. Shales	-	-	-	95
	3. Sandstone	-	-	-	30
	Shales, about	-	-	-	100 seen.

The group of beds, 1, 2, 3, seems to be one of the many forms of the ever-changing Second Grit. No. 1 is best seen where the road from Ughill Hall to Corker Walls crosses the brook; it passes downwards into hard sandy shale, and is underlaid by black shale. A little lower down the stream we cross the Ughill fault throwing down to the east, and beyond it find a sandstone, seemingly No. 1, thrown down by the fault, a band of shales No. 2, and a second sandstone No. 3, below which we find nothing but shale till we reach the Dungworth fault. Starting with this brook section the outcrops of the two sandstones have been traced, as nearly as may be, along the sides of the valley, by means of the faint features which they make, up to the Dungworth fault, the spot where they abut against the sandstone below the Ganister Coal at Rickett Field giving us a point on the fault.

Before leaving this district we must notice a very doubtful piece of ground at Low Bradfield. A rock is there quarried by the brook side, so like Rough Rock that we can scarcely believe it to be anything else. There is no clue how it came into so unlooked-for a place; but whatever may be the cause of its presence here, there must be a fault between it and the sandstone a little higher up in the village, which we have already mentioned was taken to be the topmost bed of the Second Grit, and a conjectural fault has been drawn accordingly. There are also two patches of what looks like Rough Rock on the opposite side of the valley, east of Fox Holes, which have had to be suited with faults in order to explain their position.

(6.) *The Rivelin Valley.*

This beautiful valley, which is hollowed out in a long, dome-shaped inlier of the beds below the Third Grit, and bounded on either side by craggy escarpments of that rock, falls next to be described.

As far down as the Paper Mills* the geology is simple enough. The Moscar fault ranges into the head of the valley and passes eastwards into an anticlinal, throwing off on each side the Third Grit, whose escarpments are seen at corresponding levels on each side of the valley, the underlying shales with an included sandstone bed form the flanks, and in the bottom an inlier of Kinder Scout Grit just comes out to day. We must specially notice that the Third Grit has undergone a considerable change since we last saw it on Strines Edge. There the rock had quite lost the flaggy character which it bore about Thornseat, and had

* In Map 82 N.W.

become a more thickly bedded, but not very coarse, gritstone. In the Rivelin valley it is more massive, very much coarser, and is moreover divided by long regular joints. In short, it here puts on for the first time the very marked stamp which we shall see that it keeps for a long distance to the south. The thickness of the rock was proved in the tunnel of the Sheffield Waterworks to be 174 feet; on the south side of the valley it is at least 200 feet thick.

The evidence for the course of the Moscar fault is as follows. Due south of Moscar plantation the beds in the brook are much disturbed, and lower down, south-west of Weather Cote, the fault itself is seen, its face being marked by a cliff of shattered grit, which dips S. by W. at 60°, while in the opposite bank are black shales dipping N. by E. at 35°. Eastwards from this point the fault seems to pass into an anticlinal ranging along the south side of Stump John. The low escarpments of the Third Grit on opposite sides of the anticlinal are here only about 80 yards asunder, parted by a belt of flat marshy ground formed of the underlying shales; the dip on the north side is much steeper than on the south. As we go eastwards from this point the arch flattens, the valley widens, the escarpments of the rock get farther and farther apart, till at Revell Grange* they are three-quarters of a mile from one another.

The coal on the top of the Third Grit was found in a tunnel of the Sheffield Waterworks Company to be 10 inches thick. It was also proved in cutting a conduit north of Redmires Reservoir, and south-east of Rivelin Lodge,* where it ran about two feet thick.

The marked nature of the Third Grit is well shown in the cliff of Ravelin rocks,* the joints being specially noticeable; one set, which are very approximately parallel to each other, have a mean bearing of S. 52° W.; the other set, which are not so regular, range from S. 22° E. to S. 52° E. On the opposite side of the valley the rock is well shown in Oaking Clough and Wyning Brook.* In the latter the contrast between the dark grey crags of massive grit that bound the dell on either side, the pink heather, and the deep green of the firwoods, is most charming. The rock is here and there a conglomerate with pebbles of quartz as big as a bean and half-rounded bits of felspar.

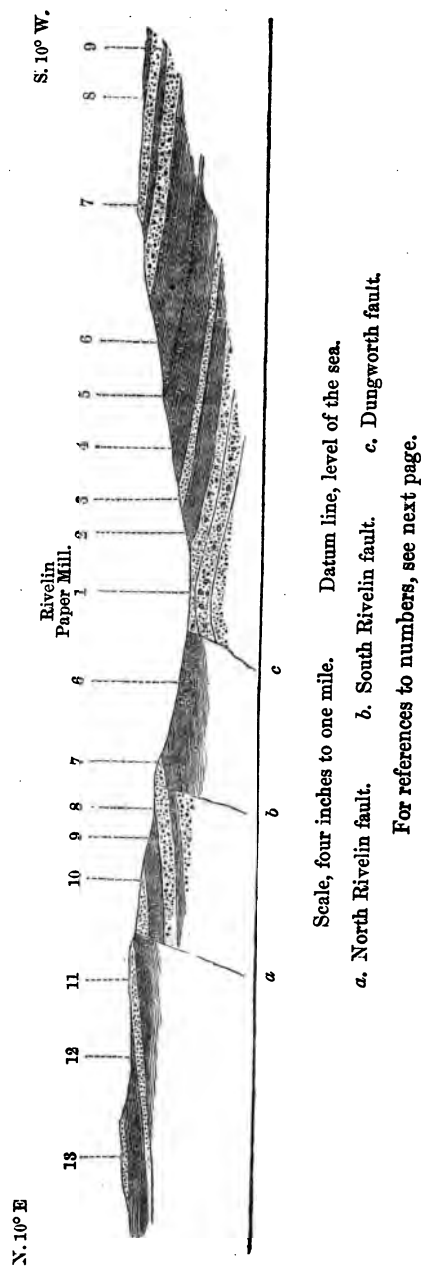
The beds below the Third Grit are shales with a sandstone bed, which is well shown where the turnpike road crosses the brook. A coal four inches thick was found in the Sheffield Waterworks tunnel 81 feet below the Third Grit.

Lastly, quite in the bottom of the valley, above the Paper Mills, we find a massive grit, not very coarse, which from its position we take to be Kinder Scout Grit.

In the lower part of the valley the geology becomes more complicated. The Third Grit, which at the western end consisted of a single bed of gritstone ranging up to 200 feet in thickness, swells out as we go eastwards, and is divided by a band of shale into two beds, the threefold group reaching perhaps a thickness of more than 300 feet. There are besides several important faults. The Dungworth fault seems to range down towards the Paper Mills. On the north of the valley the Millstone Grit beds are bounded by a fault throwing Coal Measures against them on its north side. The band of Third Grit along the north side of the valley is in like manner bounded on the north by a fault having a down-throw in the same direction; and between the Paper Mills and Bell Hagg the relative levels of the Third Grit on opposite sides of the valley cannot be accounted for by dip alone, and require that a fault, also throwing down to the north, should run somewhere between the two escarpments. To aid our explanation we have drawn in Fig. 22 a section across the valley on a true scale.

* In Map 82 N.W.

Fig. 22.
Section across the Rivelin Valley.



		ft.	ft.
Lower Coal Measures	{ 13. Sandstone below the Ganister coal.		
	{ 12. Shales.		
	{ 11. Sandstone.		
Beds between the Rough Rock and Third Grit	{ 10. Sandstone.		
	{ 9. Shales with a thin bed of sandstone, about	120	
	{ 8. Coal from - - - - -	2 to	3
	{ 7. Third Grit from - - - - -	200 to	300
	{ 6. Shales about - - - - -	200	
Beds between the Third and Kinder Scout Grits, 550 feet	{ 5. Ganister and thin coal occasionally.	-	
	{ 4. Shales - - - - -	200	
	{ 3. Sandstone, finely grained and flaggy	50	
	{ 2. Shales - - - - -	100	
	{ 1. Kinder Scout Grit.		

We will first continue our account of the measures above the Third Grit. The coal lying on that rock was proved north of Carsick Hall* and found to be three feet thick. It has been very largely worked to the north-east of Bell Hagg,* and the following rough section of one of the pits, called Hallam Colliery, and near Stephen Hill,* was given us by a collier.

Section of Hallam Colliery.

	ft.	in.
Shale - - -	52	0
Hard grey rock - - -	11	0
Shale - - -	48	0 (P)
Coal		

At a "day-hole" still at work the following particulars were given.

	ft.	in.	
Dark shale.			
Coal (pyritous) - - -	0	4 to 0	10
Coal (better quality) - - -	0	2	} Coal 2' 4" to 2' 10"
Black shale - - -	0	2	
Coal, small but clean - - -	1	8	
Dark shale - - -	0	6	
Third Grit.			

On the north side of the valley this coal was being gotten at a "day-hole" about a mile east of Revill Grange,* and the following section seen.

	ft.	in.	ft.	in.
Dark shale.				
Coal with a parting of shale	2	6		
Shaly under clay, not a fire-clay - - -	4	0 to 5	0	
Third Grit.				

This coal has also been sunk to due north of Rivelin Paper Mills; in one shaft about 8 yards deep the coal ran about three feet in thickness. A trial was also made in the angle between two roads, about 30 chains E. by N. from Revill Grange, with the following result.

		ft.	in.
Sunk	{ Surface soil and shale - - -	30	0
	{ Sandstone - - -	7	0
	{ Strong shale and bind - - -	42	0
Bored	{ Measures bored through - - -	42	0
	{ Coal - - -	2	9

The measures here correspond so nearly with those found at Ringinglowe

* In Map 82 N.W.

Colliery (see below, p. 81), that it seems very likely that the coal is the Third Grit Coal.

According to the plan explained on p. 9 the seven feet sandstone and the bed of sandstone above it, marked No. 10 in fig. 22, would, if traceable, be coloured as Second Grit; the latter alone can be traced.

We now turn to the Third Grit. The change in this rock already mentioned first begins to show itself about Rivelin Lodge,* where there is a faintly marked double escarpment, which becomes more and more distinct as we go eastwards. As far as Bell Hagg* both beds of grit are very coarse; it is difficult to estimate the thickness of the rocks, as few dips are seen, but three sections gave the following results.

Upper Grit	-	75	75	80
Shale	-	50	100	100
Lower Grit	-	95	100	130
		220	275	310

The sections are arranged in order from west to east, and, if trustworthy, show a gradual thickening eastwards. The double escarpment may be traced on from Bell Hagg* down towards the river, but the upper grit is here finer in grain than the lower. The base of the Lower Third Grit runs down to the river at Little London Wheel,* and rising again on the opposite side is very clearly traceable along the northern slope of the valley. We are, however, at once struck by the fact that the grit has here become *all at once* much thinner, and on looking closer we find that in the place of 300 feet of gritstone and shale we have not more than 80 feet of grit. The change is too sudden to allow of its having been produced by the thinning out of the bed, and we can only explain it by supposing the grit to be bounded by a fault along its north side, which throws down the greater part of the bed out of sight. This fault we will call the South Rivelin fault.

This difficulty got over, another soon presents itself. The dip of the Third Grit on the north side of the valley is such, that, even if the beds continued to rise at the same angle all across the valley, this would barely suffice to carry the Third Grit up to its position on the south side: whereas, instead of *rising* regularly from north to south all across the valley, the measures roll over and begin to *dip* south a little beyond the brook. Nothing therefore can explain the relative positions of the Third Grit on opposite sides of the valley but a fault ranging down it; and though we have no data to enable us to fix the exact place of the fault, we have put in what seemed to be the most likely line for it. To the east the throw decreases, and the fault perhaps dies out altogether: west of the Paper Mills,* as we have seen, no fault is wanted to account for the lie of the rock on opposite sides of the valley, and therefore this fault must die out in this direction also.

Again, at the Paper Mills* there are on the south side of the valley 550 feet of measures between the Third and Kinder Grits, while there are only 190 on the north side. This we have accounted for by supposing a continuation of the Dungworth fault to bound the Kinder Grit on its north side.

We now pass to the measures below the Third Grit, the best section of which is given by the stream called Black brook,* which joins the main river at the Paper Mills.*

(5.) These measures are perhaps only found here and there. In Black brook* we find about their horizon dark shales with thin layers of hard, ganister-like

* In Map 82 N.W.

sandstone, and very thin seams of brilliant coal. Further east in Samel Plantation* we have the following section in a quarry.

	ft.	in.
Black shale - - - - -	12	0
Shale with thin layers of coal - - - - -	0	9
Ganister - - - - -	3	0
Grey shale - - - - -	0	9
Ganister - - - - -	2	0
Grey shale - - - - -	5	0
Hard finely grained sandstone - - - - -	1	0
Grey concretionary shale - - - - -	1	2
Very hard siliceous stone (? Ganister) just seen.		

The hillside is so thickly strewn with debris from above that we cannot trace the outcrop of these beds continuously, but on the opposite side of the valley at Wolf Wheel* we again find a bed of Ganister with a coal smut upon it. A little of the coal was once gotten, and we were told that it was here one foot thick.

The sandstone No. 3 is well shown in Black brook.*

It remains to notice that the Millstone Grit rocks of the Rivelin Valley are bounded on the north by a line of fault which brings Lower Coal Measures against the beds overlying the Third Grit, and which we will call the North Rivelin fault.

We have not data enough to fix the exact place of this fault, but we can say for certain that it must run between Revill Grange and the ridge that stretches from Stannington to Hall Cliff, for the latter is capped by a sandstone, No. 13, in fig. 22, which when traced out is found to be the sandstone next below the Ganister Coal, and Revill Grange stands on the measures between the First and Third grits. Of the bed marked No. 11 in fig. 22 we can say nothing for certain; if, as seems mostly likely, it belongs to the Lower Coal Measures, then the fault will run to the south of it, as in fig. 22; but if the fault should be to the north of it, it will be one of the Second Grits. The Third Grit coal has been worked at a pit marked on the map south of the words "Haugh Park," and it is not unlikely that the fault was touched in these workings, but we have not been able to hear of any record of them. Lastly, to the east of Holme Head Wheel* the double escarpment of the Third Grit is stopped off in a very marked way, and this we took to be a point on the fault.

(7.) *The Rood Hill Basin, or the Country bounded by the Rivelin Valley on the North, a Line through Fox House* and Hathersage on the South-west, and the Coal Measures on the East.*

In this tract we have the entire series of beds shown, from the Rough Rock down to the upper part of the lowest Yoredale Group.

On the east the Lower Coal Measures are brought by a series of faults against different members of the Millstone Group. The latter lie in a basin, truncated on the east by the faults just mentioned, and, owing to their small dip, cover a broad spread of country, in the centre of which lies an outlier of Rough Rock forming Rood Hill. Round this outlier is a belt of the Second Grit, abutting on the east against one of the faults just mentioned; and this is encircled in turn by a belt of the Third Grit, which forms a ring of rough moorland, bounded along its outside edge by a line of rugged cliffs. Below the Third Grit, on the west, the combined escarpments of the Kinder Scout and Yoredale Grits run along the eastern side of the valley of the Derwent; while in that

* In Map 82 N.W.

valley we have laid open the Yoredale Sandstones and the upper part of the Black Shale and Limestone beds. Section No. 3. Plate I. illustrates this tract.

The supposed representatives of the Yoredale Sandstones reach in this district a greater thickness than anywhere else over the country described in the present memoir. The Lower Kinder Scout Grit is found to die away very suddenly. The Upper Kinder Scout Grit becomes markedly thinner and more finely grained. The Third Grit still keeps the very striking character it put on in the Rivelin Valley. The Second Grit is largely developed. The Rough Rock as usual.

By working from west to east we shall describe the rocks nearly in the order of their formation; we will therefore start with the valleys of the rivers Noe and Derwent, from Hope and Yorkshire Bridge, down to Hathersage.

The sections given by the River Noe between Hope and Brough are mainly in black shale, which may belong to the upper part of the lowest Yoredale group. These beds pass under a series of shales and thinly bedded sandstones, well laid open between Brough and Mytham Bridge, which lie below the Yoredale Grit and above the lowest Yoredale group, and must therefore be the equivalents of the middle division of the Yoredale Rocks or the Yoredale Sandstones. Except in Edale this group has nowhere been found in the country described in the present memoir so thick as it is hereabouts, and it seems to thin away to the south, for, with one doubtful exception, it is never seen again in that direction. In the River Derwent, between Yorkshire Bridge and Bamford, the sections are in black shale, very much disturbed and faulted; about Bamford we come upon what are certainly the same beds as those just described in the river Noe, and therefore Yoredale Sandstones. They are well laid open at Bamford Mill, and sections may also be seen in them going up the hill towards Bamford Clough, and in Hurst Clough; their thickness here cannot be much less than 300 feet.

Many sections in the same beds may be seen between Mytham Bridge and Hathersage; and we also get evidence for a line of fault, which we may as well give at once. At Sicklehome there is much disturbance and a very sharp anticlinal, and one mile lower down the river on the line of this anticlinal produced the fault itself was seen; the north wall was formed by a bed of sandstone almost on end, while on the south side the dip was more gentle, but increasing rapidly as the beds approached the fault. That it was a fault and not a mere anticlinal was shown most beautifully, thus: on the south side the beds of hard sandstone stood up out of the shales and formed little reefs across the river, and these one after the other ran up and stopped off against the wall of sandstone on the north side. The line of this fault produced eastwards, runs to Hathersage Booths, where there is a fault in the escarpment of the Fourth Grit. To the west it passes through the broken ground at Sicklehome, and then by a little bend through disturbed beds seen near Shatton, and on to a fault in the Mountain-limestone at Small Dale; the latter part of the line is conjectural.

From these sections, and from the distance between the base of the Yoredale Grit and the river, we conclude that between Bamford and Hathersage, on the north side of the valley of the Derwent, the Yoredale Sandstones reach a thickness of from 200 to 300 feet. On the south side of the valley there is a section given by the brook through Dunge Wood, and here they do not seem at first sight to be anything like so thick, for at the junction of the brook with the Derwent we find black shales with limestone nodules, apparently belonging to the lowest Yoredale group. The base of the Yoredale Grit here is, however, very ill marked, the rock gradually passing down into a mixture of shale and sandstone, and where the black shales are seen there is a very high dip, so that they may be brought up by a fault.

The black shales with limestone nodules were again seen in the lower part of Hood Brook, half way between Hathersage and Nether Hall. The nodules contained *Goniatites* in great plenty with *Posidonia Gibsoni* and *Lingula mytiloides*, and there could be little doubt that here at least we had beds belonging to the lowest Yoredale group.

We may now pass to the Yoredale Grit, a belt of which crops out along the east side of the valley of the Derwent. The rock has its usual character, sandstones, here and there coarse, with irregular masses of interbedded shale. The lower boundary is for the most part well given, though where the Yoredale Grit passes gradually into the Yoredale Sandstone group, as is sometimes the case, the line between them becomes arbitrary. The upper boundary is much of it conjectural. The fault laid down crossing Hurst Clough north of Lee Coppice has been drawn because, though the Yoredale Grit is very distinctly traceable on both sides of the valley, and ought therefore to be seen in the brook itself, we find nothing but shales, with a few thin sandstones, where the line of its outcrop ought naturally to cross the stream; and this can only be explained by supposing the rock to be thrown down to the north by such a fault as is drawn on the map, or by the very unlikely hypothesis that this thick mass of sandstone passes all at once into shale with a few thin beds of stone, and then in a distance of less than a quarter of a mile returns as suddenly to its former shape.

The rock is quarried on either side of Hurst Clough, and is also well seen in a quarry by the roadside a little to the south-east of High Lees. The face here exposed is about 50 feet high, the lower 18 feet, being all sandstone, and the rest sandstone with beds of sandy shale. The sandstone is very markedly false bedded, and micaceous, so that it splits into flags and tiles, the former ranging from an inch and a half to three inches thick, the latter averaging about half an inch. In another quarry, west of the "i" in High Lees, there were good instances of the interlacing of shales and sandstones, a vertical section showing a fan-shaped arrangement of the beds, which widen out from north to south. Besides these sections the rock is well shown in Hood Brook and the stream between Mitchell Field and Hathersage.

We now pass to the Kinder Scout Grit, the escarpment of which along the northern part of Derwent Edge, has been already described. The rock continues to form a fine ridge down to Ashopton and along Bamford Edge, and an immense landslip, or rather group of landslips, worthy of special notice, occurs above Ashopton lun. From Crow Tor down to the turnpike road the whole flank of the hill, over an area of probably as much as 30 acres, is thickly strewn with huge slipped and tumbled masses from the cliffs above; not merely large blocks, but masses of rock that must have settled down bodily into their present position. The ground is too much overgrown with timber and too much cultivated to allow any details being observed which would throw light on the formation of the slip, but, from its size, it is perhaps the most impressive instance to be found anywhere in this neighbourhood. At the south end of Bamford Edge the Lower Kinder Grit dies away altogether very suddenly, and the upper bed undergoes considerable change, shale and sandstone beds being mixed up with the grit, and the whole mass being, in places, finely grained sandstone.

Before giving the details of this change we will describe the evidence for a fault branching from the Moscar fault and running east and west past the Hurking Stones.

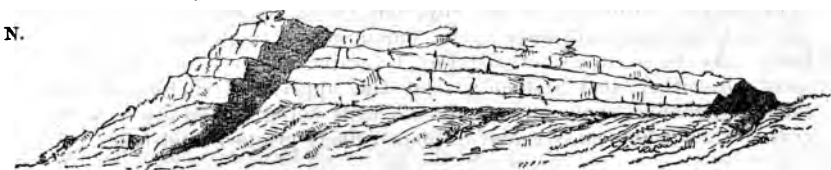
The Third Grit is shifted at Upper Reeves Low, as will be seen below: the escarpment of the Upper Kinder Scout Grit is cut off at the north end of Hordron Edge, and the fault itself seen in the brook a little further to the west; and the shales between the two Kinder Grits, which are seen in High Shaw Brook, would abut against the Lower Kinder Grit but for this fault. Hence westward matters are doubtful, but a fault having nearly the same direction, but an opposite throw, crosses the escarpment of the Lower Kinder Grit at the Hurking Stones, points to some very contorted beds in the Derwent, and may thence run to a fault seen in the Ashop near Grimbo Car, and on to a fault in the lower part of Jagger Clough.

We may now turn to the Lower Kinder Scout Grit. The rock is laid open and its base very clearly shown in Ladybower Brook, and in

the side of the valley here there cannot be less than three or four hundred feet of grit. The cliff marking the outcrop of the bed is very clear up to the southern end of Bamford Edge; here the rapid narrowing of the ridge, which is well shown by the shading on the Ordnance map, leads us to look for a change in the rock of which it is formed. On looking carefully at the cliff we see that each of the different beds in the gritstone mass makes a little subordinate escarpment of its own, and as the eye follows these along the steep flank of the hill, two at least may be very distinctly seen to grow fainter and fainter, and at last die away altogether. The diagrammatic sketch in Fig. 26, which it is hoped will explain this appearance, has been made purposely stiff and formal, and shows what would be seen, if the debris were cleared from the flank of the hill, rather than the somewhat faint hints given by the cliff itself. It will be seen that while on the left hand there are four beds of gritstone, each making a step of its own in the escarpment, two of these beds thin away, and at the extreme right only two are left and the escarpment has only two steps. Thus we get our first suspicions. A little further on we see the upper boundary of the grit in a quarry, and without making any accurate measurements we see at once that the rock here is by no means so thick as in Ladybower Brook; still further the road from Bamford to Bole Hill crosses what would naturally be the line of outcrop of the rock, and shows only a few feet of coarse grit, with a considerable thickness of shale, both above and below it. The line of this rock would run on to the "Slate Pit" marked on the map, and the flaggy sandstone seen there would seem to be the last trace of the bed. All this evidence points to a thinning away of the bed, unusually rapid no doubt; but it did not seem possible to explain the facts observed in any other way, and, moreover, south of this point we never again find any trace of a lower bed of Kinder Scout Grit. The fault already mentioned as crossing the upper part of Hurst Clough would, if produced, run along the southern end of Bamford Edge, and may be in part the cause of the abrupt change in feature there noticed.

Fig. 23.

Diagram to explain the thinning away of the Grit on Bamford Edge.



We will now notice in detail a group of sections showing the beginning of a change in the Upper Kinder Scout Grit, which we shall see as we go further south ends in that rock dying away for a while altogether.

The upper Kinder Scout Grit forms a second escarpment above Bamford Edge. The base of the rock and the shales between the two grits are well seen beside the Glossop and Sheffield road and in Jarvis Clough. The top of the rock was seen by Moscar Toll Gate, but hence southwards for three miles the shape of the ground is our only guide in drawing the upper boundary.

About Bole Hill, where the lower bed thins away so rapidly, the upper also begins to fall off in thickness and coarseness. We see this at the Slate Quarries on Bole Hill, where beds which must belong to the Kinder Grit are fine and thinly bedded enough to be worked for tilestones. At a quarry by the "d" of the word "Golden" the rock again becomes coarser, the grains being about the size of wheat; it is here rather felspathic, and contains fossil plants: east of the Paper Mill the rock is pretty much the same in character, but still forms a good cliff at the outcrop. Some quarries three quarters of a mile north-

west of Cattis Side Quarry showed the upper beds to be there fine and flaggy, very much false bedded, with wedge-shaped partings of shale. At Cattis Side Quarry we see, for the first time since leaving Moscar Toll Gate, the overlying shales, and have the following section.

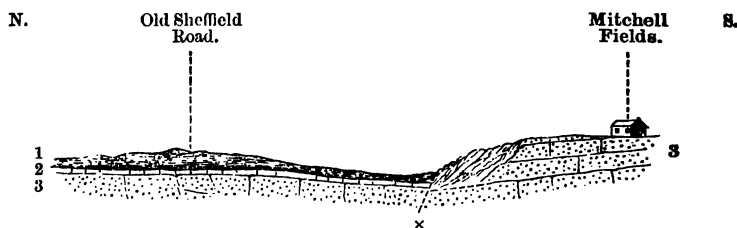
- Upper Kinder Scout Grit. {
1. Dark shales.
 2. Massive sandstone and grit, not very coarse, with beds of shale; upper beds flaggy. Thickness probably not more than 100 ft.
 3. Sandy shale with thin earthy sandstones.
 4. Yoredale Grit.

On Bore Edge the rock again becomes very coarse, bits of quartz as big as a pea or bean being very common, and the escarpment forms a low rocky cliff with somewhat of the old look about it. About Mitchell Field the rock is a massive grit, not very coarse, with flagstones in the upper part. About the "m" of the words "Dale Bottom," it is a fine grit splitting into irregular flags about two inches thick, and a little further to the east becomes rather coarser and more massive, and in one place sticks up in a natural rock. The bed has again been quarried above Hathersage Booth, where it is a grit, not very coarse, splitting into thick irregular flags.

The evidence for a fault north of Mitchell Field is mainly furnished by the following section, seen in the brook above that house.

Fig. 24.

Section in the Brook near Mitchell Field, Hathersage.



1. Black shale (*Goniatites*, *Aviculopecten* and *Posidonia*).
2. Bastard ganister with a very thin layer of coal on the top.
3. Upper Kinder Scout Grit.
- x Place of fault.

A little feature which runs from this spot to the south end of Bore Edge, where the under boundary of the grit is shifted, has been taken to mark the line of the fault.

At Hathersage Booth the Kinder Grit abuts against a fault whose line has been already described, and here we will for a while leave this bed.

In the measures between the Upper Kinder Scout and the Third Grits sections are very scarce, the flank of the hill below the escarpment of the latter being thickly covered with a mass of debris of Third Grit which hides the bedded rocks from sight. From the shape of the ground we should infer that here and there at least one sandstone bed lay among the shales.

We get sections at last on Hathersage Moor, and there find the order to be

1. Third Grit.
2. Shales, not seen.
3. Thin flagstone (quarried about the "r" of "Hathersage Moor").
4. Sandy shales.
5. { Sandstone, rather coarse and concretionary } Well seen about the
- { Shale - - - - - } "t" of "Hather-
- { Finely grained sandstone - - - } sage Moor."
6. Thick mass of dark shale.
7. Kinder Scout Grit.

The group No. 5 form a very marked feature at the spot mentioned, and a ridge probably marking its outcrop may be traced on the north as far as a large plantation marked on the map beneath Stanage Edge, and on the south

certainly as far as Millstone Edge. The sandstones have been quarried for about a quarter of a mile in the former direction, and seem to become less massive, and to be split up by shales. Good sections of these beds are also given by Burbage Brook, and we there find like sandstones interbedded with the shales.

We now come to the Third Grit, the bed which forms by far the most striking features in the scenery, not only hereabouts but for many miles to the south. We have already mentioned in the account of the Rivelin Valley that this rock had there begun to put on that marked character which distinguishes it from the other gritstones, and in the present district its peculiar stamp comes out still more strongly, and is shown perhaps better than anywhere else on Crow Chine.

From this hill the escarpment runs along Stanage Edge and the west of Burbage Moor, a bold rampart of rock, with a nearly vertical face, from 20 to 50 feet in height, below which is a steep slope formed of the underlying shales. The joints, which are very strong and regular, split up the rock into huge masses, roughly prismatic in shape, and give the cliff a somewhat battlemented look; and the steep slope below is thickly strewn down to the very bottom with fallen masses of the grit, so that it is only very rarely that we catch a sight of the shale of which it is formed: these blocks are of all sizes, and for the most part angular, and lie as if they had quietly settled down into their present position. We can only account for them by supposing that the escarpment of the grit once lay farther to the west, and that it has been carried slowly eastwards as the underlying shales were worn away by atmospheric action, and the rock thus deprived of its support broke off along the face of the joints, and left the ruined masses which now cover the flank of the hill to show what once had been its extent. These loose blocks are quarried for building and millstones, and are called by the workmen "day stones."

The rock is mostly coarse, massive, and regularly jointed, often a conglomerate with pebbles of white quartz up to the size of a thrush's egg. We find here and there the lower flaggy part present, but it is mostly thin, and over a great part of the district wanting altogether.

To pass to details. The fault at Upper Reeves Low, already mentioned, shifts the base of the rock very distinctly, and there is another detached patch of the grit, which, if in place, must have been thrown down again by a cross fault. South of this fault along the escarpment of Broad Rake up to Crow Chine the upper part of the bed is a very coarse massive grit, often false bedded, and in many cases a conglomerate with quartz pebbles and bits of felspar as big as a bean. There are faint traces of fossil plants. The stone is used for building and engine beds. Below the cliff formed by this coarse part is a second escarpment, less steep, made of flaggy sandstone. This second escarpment is shown by the shading on the map, and it will be seen that it ends off suddenly ¼ mile south of the Trigonometrical Station on Crow Chine; and here, as we should expect, the flagstone seems also to die away, for, though there are no actual sections to appeal to, springs begin to come out immediately at the foot of the coarse grit, pointing to shale close beneath.

Towards the north of Stanage Edge millstones have been made out of the grit; they were described as fit for grinding oats, but too "nesh" (weak) for beans or barley.

The following sets of joints were measured between Crow Chine and Coal Pit House.

- | | |
|-----------------------------|-----------------------------|
| 1. E. 60° S., and E. 28° N. | 4. E. 65° S., and E. 40° S. |
| 2. E. 72° S., and E. 30° N. | 5. E. 50° S., and E. 40° N. |
| 3. E. 55° S., and E. 30° N. | 6. E. 20° S., and E. 40° N. |

Mean direction, E. 53° 40' S., and E. 34° 40' N.

On Stanage Edge the following directions of joints were measured, in order from north to south.*

- | | |
|---------------------------------|---|
| 1. E. 65° S., and E. 40° N. | 22. E. 40° S., and E. 70° N. |
| 2. E. 65° S., and E. 32° N. | 23. E. 40° S., and E. 70° N. |
| 3. E. 83° S., and E. 18° N. | 24. E. 30° S. |
| 4. E. 50° S., E. 20° N., and E. | 25. E. 15° S. |
| 5. E. 35° S., and E. 48° N. | 26. E. 80° S., and E. 20° S. |
| 6. E. 40° S., and E. 38° N. | 27. E. 25° S. |
| 7. E. 27° S., S., and E. 32° N. | 28. E. 25° S., and S. |
| 8. E. 60° S., and E. 60° N. | 29. E. 42° S., and E. 60° N. |
| 9. E. 40° S., and E. 60° N. | 30. E. 30° S., and E. 50° N. |
| 10. E. 30° S., and N.E. | 31. E. 70° S. |
| 11. E. 32° S., and N.E. | 32. E. 40° S., and E. 30° N. |
| 12. E. 26° S., and E. 50° N. | 33. E. 25° S. |
| 13. E. 60° S., and E. 40° N. | 34. E. 20° N. |
| 14. E. 27° N. | 35. E. 10° N. |
| 15. E. 35° N. | 36. E. 70° S., and E. 73° N. |
| 16. E. 42° S., and E. 30° N. | 37. E. 60° S., and E. 40° N. |
| 17. E. 38° S., and E. 58° N. | 38. E. roughly, and E. 58° N. |
| 18. E. 50° S., and E. 30° N. | 39. E. 25° S., E. 70° S., and E. 50° N. |
| 19. E. 40° S., and E. 60° N. | 40. E. 20° S., E. 55° S., and E. 75° N. |
| 20. E. 32° S. | 41. E. 32° S., and N.E. |
| 21. E. 30° S., and E. 55° N. | |

Mean direction, E. 43° S., and E. 46° N.

The account of the upper boundary of the Third Grit was carried in the description of the Rivelin Valley as far as a conduit above the Redmires Reservoirs. The coal lying on the top of the rock has been worked in the upper part of Oaking Clough, and again about Coal Pit House, but the pits have been long abandoned, and except at these two points the line of the crop is very uncertain, but there seems to be little doubt that Hallam Moors are covered by a broad spread of the gritstone. A fault in the upper boundary to the west of Oaking Clough was seen in the book, the coal and its underclay being bent up into a vertical position on the north side against a mass of coarse grit on the south side.

Though we can make nothing out of them ourselves, we give the three following sections, which were found among the papers of the late Mr. W. B. Mitchell of Sheffield.†

1. Bore hole in Oaking Clough :

	ft.	in.
Soil and clay	-	7 0
Bind	-	10 0
(1) Coal	-	2 0
Bind	-	21 0
Coal (? Third Grit Coal)	-	2 6
Fireclay	-	2 0
Hard Rock (? Third Grit), bored into	-	17 0

2. Bore hole on Stanage Moor :

Peat and soil	-	5 0
Rock	-	32 0
(1) Coal	-	1 6
Fireclay	-	2 0
(2) Gritstone Rock	-	29 0
Rattler or Cannel Coal (? Third Grit Coal)	-	5 6

3. Open pit on Stanage Moor :

Peat and (query loose blocks of) gritstone	-	12 0
(1) Coal	-	0 1
(2) Grey Rock	-	18 0
Shale	-	4 0
Rattler or Cannel Coal (? Third Grit Coal)	-	5 6

* See on the subject of joints, p. 143.

† These papers were kindly placed in our hands by Mr. Mitchell Withers.

These sections, if trustworthy, seem to show that hereabouts there lies almost close upon the Third Grit Coal a bed of sandstone from 20 to 30 feet thick, marked (2) in the above sections, on which rests another coal bed, marked (1) in the above sections, very variable in thickness. The "rock 32 feet" in No. 2 need not be sandstone, as hard stony shales are often so called by colliers.

The coal lying about at Coal Pit House was some of it bright and clean, and some a very earthy cannel or carbonaceous shale.

At the southern end of Stanage Edge the Third Grit is thrown eastwards by a fault, and covers a broad tract of country over Burbage and Ankirk moors. The lower boundary is marked by a line of fine crags overlooking the valley of Burbage Brook, along which the following sets of joints were measured.

- | | |
|-------------------------------|--|
| 1. E. 60° S., and E. 50° N. | 5. E. 57° S., and E. 30° N. |
| 2. E. 70° S., and E. 65° S. | 6. E. 65° S., and E. 22° N. |
| 3. E. 70° S., and E. 30° S. | 7. E. 40° N., and E. 15° N. |
| 4. E. 60° S. | 8. E. 50° S., E. 25° N., and E. 40° N. |
| 9. E. 20° S., and E. 55° N. : | |

and near Parsons-House* the following.

- | | |
|-----------------------------|--|
| 1. E. 55° S., and E. 35° N. | 3. E. 50° S., E. 55° S., and E. 35° N. |
| 2. E. 72° S., and E. 20° N. | 4. E. 60° S., and E. 35° N. |
| 5. E. 65° S., and E. 60° N. | |

In a quarry near here is a very fine section of the grit, which is evenly and massively bedded, closely grained, and not very coarse, the grains being on an average about the size of wheat, or perhaps smaller. It is worked for grindstones used for crushing seed, shelling oats and rice, and grinding peas, beans, Indian corn, and everything but wheat.

Near Fox House* the lower boundary of the Third Grit abuts against a fault, which is most clearly shown in a general way by the shifting of the rock from Burbage Moor to the more westerly escarpment beginning at the northern end of Booths Edge, and the detailed evidence for which will be given in the account of district 9. Here for the present we will leave the base of the Third Grit.

To the west of the main mass of the Third Grit there are some outliers, and detached faulted patches of the rock on Hathersage Moor, whose position will be best understood by turning to the map. On the outlier of Higgaw Tor the following sets of joints were measured.

- | | |
|------------------|-----------------------------|
| 1. N.E. and S.E. | 3. E. 30° N., and E. 30° S. |
| 2. N.E. | 4. E. 20° N., and E. 75° S. |

and on the Carl Work the following.

- | | |
|-----------------------------|-----------------------------|
| 1. E. 80° N., and E. 20° S. | 3. E. 30° S., and E. 60° S. |
| 2. E. 10° S., and E. 80° S. | |

The upper boundary of the Third Grit is approximately given above Upper Burbage Bridge, but cannot be exactly fixed again till we reach the old workings in the coal on the top of the grit one mile west of Ringinglow,* which enable us to lay down the crop accurately. The junction is well shown in the upper part of Fenny Brook,* the stream running for some distance on the top of the grit, while the banks on each side are formed of the overlying shales. About 16 chains below the Copperas Works† the grit dips below the surface, but a little lower down is again just brought out to day either by a roll or by a small fault, and a narrow band of the rock runs along the bottom of the valley a little way into Bole Hill Plantation.* To the south of this valley the coal crop was traced, either by sections or old workings, beyond the Long Lane, and then the line again became doubtful up to a fault ranging along the east side of Blacka Plantation,* which we will call the Easterly Blacka Hill fault. To the east of that portion of the upper boundary which lies between this fault and Fenny Brook there was no trace of either the Second or First Grits, and there is little doubt that the beds there seen, which will be described below, are Lower Coal Measures; a fault is therefore required, and,

* In Map 82 N.W.

though its exact place is doubtful, the line laid down on the map cannot be very far from the true one.

The Easterly Blacka Hill fault is seen in the brook east of the "B" in Bole Hill;* it cuts off the escarpment of the grit forming Blacka Hill,* accounts for the abrupt ending off of the Third Grit on the east of Blacka Plantation,* and there is some little further evidence for it, which we will give below, east of Oxdale Lodge.*

The grit ridge of Blacka Hill† is again stopped off on the west by another fault, the line of which is very clearly given by the terminations against it of the escarpments of two sandstone beds on its western side; this we will call the Westerly Blacka Hill fault.

Between these two faults the upper boundary of the Third Grit can be only approximately fixed. The grit bed next above is that forming Blacka Hill. This is coarse and massive, quite unlike the Second Grit, but would do well enough for Rough Rock, and the beds above are certainly Lower Coal Measures. We have therefore coloured Blacka Hill† as Rough Rock, and supposed the Second Grit to be wanting here. It is, however, possible that the upper boundary of the Third Grit is a fault, and that the Second Grit is not wanting, but thrown out of sight by this fault. Again, it is far from unlikely that the Blacka Hill rock is a Coal-measure sandstone, and the upper boundary of the Third Grit a fault, throwing down both the Second and First grits.

Between the Westerly Blacka Hill fault and the fault already mentioned through Fox House,‡ the shape and nature of the ground enable us to lay down the upper boundary of the Third Grit pretty closely. Above this rock we find the escarpments of two sandstone beds parted from each other and from the Third Grit by shales, and naturally expect them to turn out to be the Second and First Grits. On examination, we see that neither of them can be Rough Rock, and we have therefore our choice of two schemes for trial. First, the upper may be a Coal-measure sandstone, and the lower the Second Grit, and a fault may run between the two: or, secondly, they may both be Coal-measure sandstones, and a fault may run between the lower and the Third Grit. The fault required on the first hypothesis would have a very sudden and awkward bend, and we have therefore adopted the latter.

It remains to notice an inlier of the shales below the Third Grit on Ankirk Moor. The exact details are doubtful, but the beds are shown in the upper part of Rediker Brook. The hill-sides are too thickly covered with debris to allow of the junction with the Third Grit being anywhere seen, but a line of crags has been taken to mark the base of the latter; and on the east and west sides, where these guiding features fail, continuations of the Easterly and Westerly Blacka Hill faults have been taken as boundaries.

Before taking in hand the Second Grit it will be well to mark out the line of fault by which the broad spread made by that rock is bounded on the east. Near Clough Field* is a quarry in Lower Coal-measure sandstone, and hard by this the coal lying on the Third Grit was worked at a depth of 32 yards, the fault must therefore run between the quarry and the coal pit. At Ran Moor* a closely grained gritstone lying on a two-foot coal is quarried, which must belong to the Lower Coal Measures; the beds rear up at angles of 30° and 40°, and immediately to the west of the quarry are the shale measures between the Second and Third Grits; here then we have another point on the fault. Disturbed beds most likely on the line of this fault are seen in a brook about one third of a mile to the south-west of Ran Moor.* We find our next evidence in the brook below Whitely Wood School.* The base of the Second Grit crosses the stream just at this spot, but instead of finding this rock for some distance down the valley, as we should naturally expect, we pass all at once on to a group of shales and thin sandstones, broken and very much contorted. South of this point we have on the west of the line the Second Grit, and immediately to the east the Ganister and another coal have been worked, and the

* In Map 82 N.W.

† See p. 65.

absence of the Rough Rock and a great part of the Lower Coal Measures calls for a fault. This we will call the Fulwood fault.

The beds between the Third Grit and the Rough Rock, though variable, do not show in the present district such remarkable changes as those described in the account of the neighbourhood of Moscar and Bradfield. To show this, we put side by side three sections: No. 1, at the extreme west of our district; No. 2, about Ringinglowe,* in the centre; and No. 3, near Carsack Hill,* in the north-east corner.

Comparative Sections of the Beds between the Rough Rock and Third Grit in the Rood Hill Basin.

No. 1.		No. 2.		No. 3.
	ft. in.		ft. in.	
1. Rough Rock.		1. Rough Rock.		1 and 2 not present.
2. Shale - 125	0	2. Shale - 125	0	Mixture of Sandstone and
3. Sandstone - 100	0	3. Sandstone - 150	0	Shale, not admitting of
4. Shales - 110	0	4. Shales - 170	0	any regular subdivision.
5. Sandstone - 50	0	5. Sandstone - 17	0	ft. in.
6. Shales - 100	0	6. Shales - 100	0	6. Shale - - 80
7. Coal.		7. Coal - 4	6	7. Coal - - 3
Third Grit.		Third Grit.		Third Grit.

In No. 1 the sandstones 3 and 5 were well marked enough to be traced, and they have therefore been laid down separately and coloured as Second Grit. In No. 2 the sandstone 5 was too thin and irregular to allow of its being traced with certainty, and, except for a short distance, 3 alone is coloured as Second Grit. In No. 3 we have a mixture of shale and sandstone too changeable to allow of any subdivisions being established, and the whole mass is coloured as Second Grit.

The escarpment of the lower sandstone (5) is best marked to the north of Lord's Seat, and may be followed eastwards for about a mile and a half, when it fails altogether, and the bed most likely dies out. Westwards the rock may be traced to the south of Lumley Lodge, and here again the escarpment disappears, and we have supposed the bed to die away. What seems, however, to be the same bed was found in the shaft of Ringinglowe* Colliery (see Sect. below), its outcrop makes a clear ridge for some distance east and west of that spot, and as far as it could be traced has been laid down on the map.

The upper sandstone (3) has been quarried on Lord's Seat, where it shows as a flaggy sandstone. At Stanage Pole, what there seems good reason to think is the same bed has the form of a thickly bedded, fine, closely grained grit. Westwards from Stanage Pole the escarpment becomes fainter and fainter, and though we have carried a hypothetical line of the bed across White Moss, it is not at all unlikely that the rock for awhile dies away altogether. On Brown Edge,* however, we again find the sandstone in force, and it has been very largely quarried there and about Fulwood Head,* the thicker beds yielding fair building stone, and the thinner beautiful flags and tiles. With the exception of the part mentioned on White Moss, the under boundary of this sandstone is very clearly marked, and can be followed on the map.

We may here give the section of Ringinglowe* Colliery; corrected for dip, it is as follows.

Section of Ringinglowe Colliery.

		ft.	in.
4. Shale	-	81	0
5. Closely-grained sandstone	-	17	0
6. Shale	-	98	0
		ft.	in.
7. Coal	-	1	0
	{ Coal, fair quality	0	9
	{ Black, coaly shale	2	9
	{ Coal, inferior		
Underclay	-	1	0
Third Grit.	-		

* In Map 82 N.W.

The numbers refer to the same beds as in the table of Comparative Sections on the last page. The dip at the pit bottom is 10 inches to the yard, but towards the crop falls off to 5 inches to the yard.

Eastwards from Ringinglowe* the upper sandstone, No. 3, stretches along the top of the hill up to the Fulwood boundary fault, and the lower boundary is well marked, both on the north and south sides. A little patch of the overlying shales* is seen at Wigley farm,* and a thin coal was found at the junction in a well, which gave the following section.

	ft.	in.
Black shale with <i>Goniatites</i> and <i>Aviculopecten</i> in the lower part	30	0
Coal smut.		
Underclay	-	2 6
Flaggy sandstone. No. 3. of the table of Comparative Sections on last page.		

The section in Fig. 25, opposite, will illustrate the structure of the country just described.

A word must be said about the lower part of the valley of Fenny Brook.* The base of the sandstone No. 3 runs along the north side of the valley below Bole Hill Plantation* down to the stream a little above Whirlow Bridge.* The dip is very nearly down the valley, and we should expect to find a like cliff of this rock on the south side; nothing of the sort, however, is seen, and instead we have beds which there is every reason to think are Lower Coal Measures. There must therefore be a fault ranging along the valley, and a fault has accordingly been drawn on the map as well as the scanty evidence would allow.

On the upthrow side of this fault a patch of ground called Stand Hills* is covered with loose blocks of Third Grit, and though the rock is nowhere actually seen in place, there is so much of it lying about that it seems highly likely that the bed does crop out there. Also in the brook we see the top of a coarse grit bed overlaid by black shales, which pass under the Second Grit on the hill top, and this is therefore most likely the Third Grit. We have on these grounds put in a little faulted inlier of the Third Grit in the bottom of the valley.

If we now cross to the north side of the valley of Porter Brook, we shall find a patch of ground, in the centre of which stands Fulwood Church,* covered by sandstones and shales, which are certainly the equivalents of the beds 3, 4, 5, in Sects. 1 and 2 of the table of Comparative Sections, on page 81.

The detailed structure of the country cannot, however, be very satisfactorily made out, and Sect. 3 of the same table tells nearly all we can say for certain about it. The sandstone on the western part seems to be the equivalent of No. 5, which after having died out for a while sets in again about Birk Green,* and covers the northern flank of the valley, the slope of the ground being nearly the same as the dip of the beds, and the upper boundary of the grit running nearly along the brook, in which several junctions with the overlying shales were seen. To the east we seem to have the bed No. 3, but the country is too well cultivated and sections are too few to allow of the two sandstones being traced out separately, and the whole ground has been therefore tinted with the colour for Second Grit.

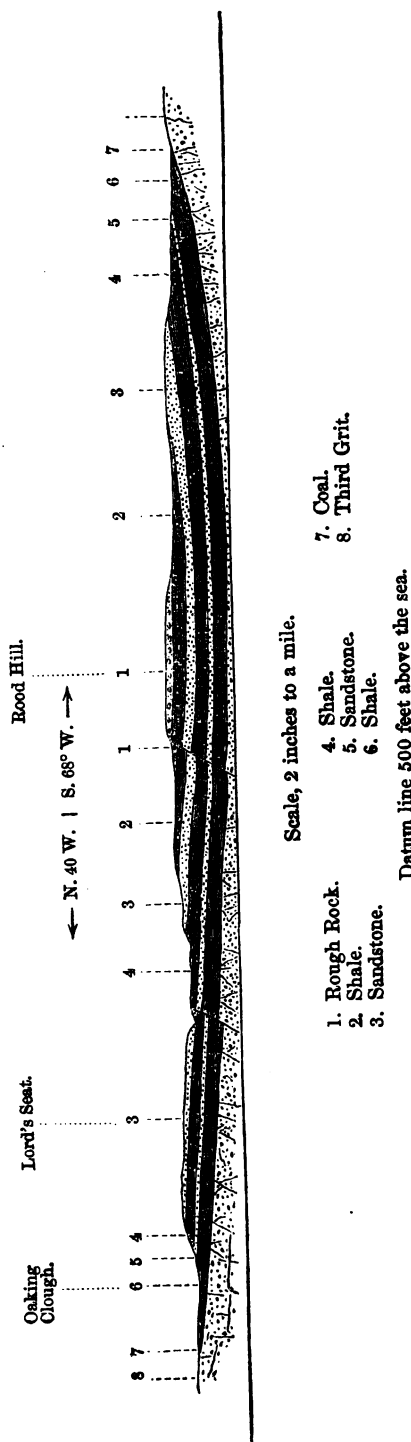
The above explanation will require one or more faults; the only one for which we have any evidence was seen in the brook near the "e" of "Old Mill House."*

The Third Grit coal was found in a boring at Fulwood Mill* at a depth of 117 feet.

A small outlier of sandstone, which we believe to belong to the Second Grit, is found in the north-east corner of the district at Sandy Gate;* it is bounded on the east by the Fulwood boundary fault, and on the north-west by a fault found in the workings of the Third Grit Coal.

* In Map 82 N.W.

Fig. 25.
Section from the Head of Oaking Clough to Ringinglowe.



(8.) *The Country from Hathersage on the North to a Line through Stoney Middleton and Eyam on the South, between the Mountain Limestone on the West and South, and the Valley of the Derwent on the East.*

In this district we have a broad spread of Yoredale Grit on Abney Moor, and a tract of the Upper Kinder Scout Grit ranging from Eyam Moor down to Curbar.

The thickness of the beds is about as follows :—

		ft.
Millstone Grit.	Upper Kinder Scout Grit.	
	Shales, perhaps about - -	100
Yoredale Rocks	Yoredale Grit - -	80 to 460
	Black shales with limestones - -	330
Mountain Limestone.		

Horizontal Section, Sheet 70, crosses the southern part of this district.

Yoredale Grit.—We have already traced the outcrop of this bed down to the fault running through Hathersage Booths and Sickleholme. There are no sections to fix exactly the spots where its upper and lower boundaries cross the Derwent, but to the south of the river the rock spreads out and forms a tract of high ground, in the middle of which is the hamlet of Abney. The lower boundary of the rock is well given by brook sections, and by the shape of the ground, which mostly shows a double escarpment above the boundary, owing to the presence of a shale band about 15 or 20 feet thick, whose outcrop is marked by a little terrace running between the steep escarpments of the sandstones above and below it. A like band of shale has been already noticed elsewhere in the Yoredale Grit. A fine section of the rock is given at Bar Tor, where a large landslip has laid bare a vertical cliff; good sections are also yielded by the stream through Dunge Wood and by Highlow Brook; the latter divides a little above Highlow Mill, and the southern branch cuts down to the shales and sandstones beneath the Yoredale Grit, a long inlier of which stretches for some way along the valley, the beds rising from each side gently towards the middle. Along the south bank of the stream are many landslips, such as are found so frequently along the line of junction of the Grit with the underlying shales where the beds dip into a valley. A strip of Yoredale Grit runs southwards from this tract, forming a steep ridge to the east of Eyam and Stoney Middleton.

The measurements we have of this rock, if they are trustworthy, show that its thickness is here very changeable. About Abney it cannot well be less than two or three hundred feet thick; in the shaft of the Lady Wash mine there are said to have been 466 feet of it, while an old plan of Stoke Sough in the office of Mr. Aston of Castleton made it 200 feet thick. Between Eyam and Stoney Middleton it is most likely not more than 80 feet thick.

Not a single section was seen in the shales between the Yoredale and Kinder Scout grits, and the upper boundary of the former is therefore conjectural.

The Kinder Scout Grit in this district, though still coarse in places, has very much the same character as to the immediate north of Hathersage; at its base is a belt of good flagstone, with interbedded sandy shales.

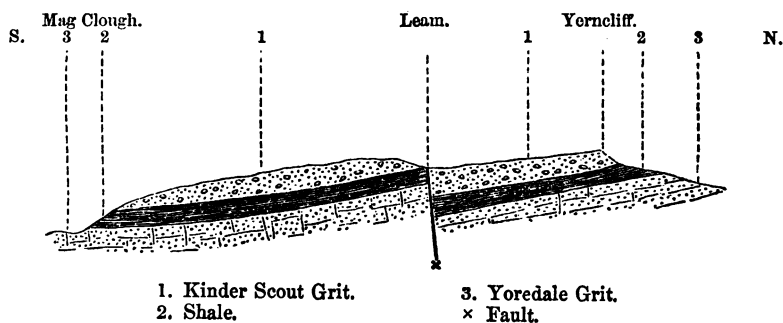
Before we pass to the account of this rock it will be convenient to notice an important fault ranging across the district in an east and west direction. The western part of this dislocation is formed by the Hucklow Edge Lode, which has been proved by mining in the Mountain Limestone, either at the surface or below the covering of Yoredale Rocks, and found to be a fault down to the north, from near Peak Forest to the Ladywash Mine, a little to the west of which it cuts off the escarpment of the Kinder Scout Grit on Sir William Hill in a very marked way. Along the line of this fault produced, the base of the

same rock is also stopped off, though not in so undoubted a manner, on the south side of Mag Clough. Hence we have no evidence till the eastern side of the Derwent valley, but there, in Hay Wood, which lies very nearly on the line of the fault produced, we find the escarpment of the Third Grit very much broken. The fault here seems to split into three branches, and though the exact details of the displacement are doubtful, it was quite clear that a single fault would not account for them, and out of several possible arrangements of the lines that on the map was chosen as explaining most easily the observed facts.

We will first take in hand the ground to the north of the fault. A fault ranges north-west and south-east through Leam, the evidence for which we shall be better able to give further on; we will first say about the Kinder Grit to the north of it, that its under boundary is clear throughout, but that the eastern slope of the Derwent valley is so thickly covered by tumbled masses of the Third Grit that there is no evidence to fix its upper line. We naturally look to Burbage Brook for a section, and here the shales and sandstones below the Third Grit are fairly shown down to the Upper Mill; below this shale is again seen in one place, and at the Lower Mill we come on to flaggy sandstone, which may be followed to the bottom of the wood; in spite of its mineral character, which is so unlike the usual run of the Kinder Grit, we thought that this sandstone, lying as it does, must be the upper part of that bed, and have drawn the line accordingly.

We will now come to the fault just mentioned ranging through Leam. If we go back to the western side of the river we shall find the ground sloping down gently to the south from the escarpment of the Kinder Grit at Yerncliff as far as Leam, as shown in the section, fig. 28. Through Leam there ranges in a W.N.W. line a ridge of higher ground looking at first sight exactly like the escarpment of a bed overlying the Kinder Scout Grit. This, however, cannot be the case, and we are therefore led to explain this ridge by supposing a fault along its base throwing up to the south the Kinder Grit, and so repeating its escarpment. Whether the underlying shales are really brought out to day by the fault, as in the section, is doubtful; the steep slope of the ground and some strong springs that break out seem to show that they are, but no section of shale was seen, and none has therefore been marked on the map.

Fig. 26.

Section through Leam Hall.

Again the prolongation of this fault across the valley explains matters that are at first sight very puzzling. A section running from Sheriff Wood down to the Derwent shows the following beds:—

- | | | |
|---|---|----------------------------|
| 1. Coarse massive grit | - | } Lower Kinder Scout Grit. |
| 2. Fine flagstone with shale partings | - | |
| 3. Shale. | | |
| 4. Sandstone with shale partings
(seen in the river bank). | - | Yoredale Grit. |

No. 4 is shown at a bend of the river opposite the word "Sheriff;" No. 3 at the south-east corner of Sheriff Wood, and again on the carriage road up to Leam. No. 2 is largely quarried a little to the north of Grindleford Bridge, and its outcrop may be traced into Sheriff Wood, where it is seen to be immediately overlaid by the undoubted Kinder Grit No. 1. Nos. 1 and 2 will, therefore, be Kinder Scout Grit, the base taking here a flaggy form, and No. 4 Yoredale Grit, and we have therefore Yoredale Grit here in the bed of the river, while on the opposite side of the valley is Kinder Scout Grit on the same level. Between the two there must be a fault, and the fault through Leam runs as neatly as could be wished to the spot where it is wanted, and clears up the difficulty.

A little inlier of Yoredale Rocks, bounded on the south by the Hucklow Edge Lode, has been laid down in Mag Clough. The base of the Kinder Scout Grit is well marked, specially on the north side of the valley, and is seen in several places to be a flaggy sandstone like No. 2 in the section last given. The top of the Yoredale Grit can only be guessed at, but the rock is seen in the brook, and was sunk through in the shafts of an adit called Mag Clough Sough.

We now return to the base of the Kinder Grit at the west end of Yerncliff. The line is here shifted by a fault, bringing the Yoredale Grit, which has been worked in Wet Within Slate Quarry, on a level with the crags of the Kinder escarpment. The latter rock is found again on Stanage, along which it runs with a very clear line up to the Hucklow Edge Lode at Sir William Hill. It is shifted by two faults, of which the more westerly is somewhat doubtful.

We now pass to the south side of the Hucklow Edge Lode. The lowest Yoredale Group, though seldom seen in natural sections, has been proved in the mining shafts to be about 300 feet thick.* There is no certain trace of the Yoredale Sandstones, and the division is either very thin or has died away altogether. The Yoredale Grit makes a bold ridge, and in the shaft of Lady Wash Mine was found according to the miners to be 466 feet 6 inches thick, the section, given us by Mr. Maltby of Eyam, being as follows:—

Section of the Lady Wash Mine.

	ft.	in.	
Gritstone - - -	466	6	Yoredale Grit.
Black shales with beds and nodules of earthy limestones - - -	330	0	{ Lowest group of the Yoredale Rocks.
Mountain Limestone.			

A fault ranging south-east through Goatscliff was laid down from the following evidence. A fault seen in the Third Grit on Froggatt Edge points to a line of vertical beds in the Derwent, and then its line produced would run very nearly to a point where the escarpment of the Kinder Scout Grit is faulted a little west of Goatscliff. In the angle between this fault and the Hucklow Edge Lode the Kinder Grit was nowhere seen, but there are sections in the overlying shales in the lower part of Hay Wood, and by the roadside south of Goatscliff Tannery.

To the south of the fault last mentioned a belt of the Kinder Scout Grit runs from Stoke Moor to Calver. It is found on Stoke Moor to be coarse and massive, and it makes a clear little escarpment as far as Rock Hall. Southwards from here the escarpment is less marked, and the rock seems to become finer, and three-eighths of a mile south-east of Riley House the lower part is a finely grained flaggy sandstone, very much false-bedded and mixed with sandy shale. This rock, which is largely quarried for flags and tilestones, is just the same as the beds we found at the base of the Kinder Grit between Grindleford and Leam. The rock may also be seen in the grit quarries one quarter of a mile S.S.W. of Goatscliff, where it is a massive grit, not very coarse; and near Stoke Hall, where it is a finely grained, thickly bedded sandstone with shale beds. It keeps this latter character down to Calver,† where it abuts against a fault which we will call the Stoney Middleton fault. The upper boundary is

* At the Lady Wash Mine the following fossils, determined by Mr. Etheredge, were found in these beds. *Goniatites sphaericus*; *Posidonomya Gibsoni*; *Posidonomya* sp.; *Scales of Palæoniscus*.

† In Map 81 S.E.

throughout wholly conjectural, for the whole of the eastern slope of the valley is thickly covered with a tumbled mass of blocks of Third Grit, and no sections were seen.

The ground is smothered in the same way all along the deep valley of Barbrook,* but a bed of hard sandstone crops out in the stream a little north of the tollgate, and has been taken to be the Kinder Scout Grit.

We will now give the evidence for the Stoney Middleton fault North of the village a lode has been worked, on the line of which the warm spring breaks out. The lode produced runs to Calver,† where the Kinder Scout Grit and the Mountain Limestone run very close together, no trace of the Yoredale Grit being found between them. This requires a fault down to the north-east. Carrying on the line, it bounds on the north-east an outlier of Kinder Scout Grit on Baslow Bar,‡ which seems to be sharply cut off and brought very close to the Third Grit of Baslow Edge,‡ calling for a fault with the same throw as before. Lastly, where the line produced cuts the escarpment of the Third Grit north of Chatsworth Park* there is a fault, also down to the north-east. The throw is here small, and the fault has nearly died out.

(9.) *The Country from the Stoney Middleton Fault on the North to Rowsley on the South, between the Mountain Limestone on the West, and the Chatsworth Fault on the East.‡*

On the west of this district we have the black shales and limestones of the lowest Yoredale group, but the main feature in the geology is the broad spread of Yoredale Grit which rises steeply from the flat country formed by these beds and ranges from Baslow through Edensor, almost down to Rowsley. This is well shown on the Horizontal Section, Sheet 18, of the Geological Survey. There are also two outliers of Kinder Scout Grit.

These beds, and their probable thicknesses, are shown in the following table :—

	Feet.
Kinder Scout Grit.	
Shales, perhaps about - - - -	100
Yoredale Grit, variable, up to - -	300
Shales with limestones in the lower part - -	500
Mountain Limestone.	

The junction of the Mountain Limestone and the Yoredale beds was seen in some mining tunnels in Dale Wood, the beds rearing up at angles of from 50° to 60°. The lowest Yoredale beds, black shales with thin limestones, are seen here and there, as in the brook between Hassop Village and Hassop Station, and they are again well laid open in the railway cuttings between Bakewell and Rowsley.

We have nowhere been able to find any trace of the supposed representatives of the Yoredale Sandstones between Calver and Hassop Station. To the west of Bow Cross, however, we get the following section.

	1. Yoredale Grit.
	2. Gap with no section, probably shale.
Yoredale Sandstones?	3. Sandstone, 1' 0".
	4. Dark micaceous shales with a few thin sandstones.
	5. Black shale.
Lowest Yoredale Group.	6. Gap.
	7. Black shale with limestone nodules containing plants and <i>Goniatites</i> .

* In Map 82 S.W.

† In Map 81 S.E.

‡ This district lies in Map 81 S.E.

The bed (3) in spite of its thinness makes a very well-marked feature for some distance on either side of this section, and may be seen again in the railway cutting by the words "Edge Quarries" on the map. It seems, however, to die away both to the north and south. We have thought that 3 and 4 may perhaps be the feeble representatives of the Yoredale Sandstones, which having died away from Stoney Middleton southwards, here set in again for a while in a thin form.

We may now pass to the Yoredale Grit, which is seen best of all in the large quarries at Bow Cross. It here consists of sandstones, some flaggy and some thickly bedded, with partings and thick irregular masses of interbedded shale. Some of the beds yield beautiful building stone, and of the stone from these quarries the fronts of Chatsworth, Bakewell Church, and the Crescent at Buxton are built.* One of the quarries gave the following section :—

	Feet.
Sandstone - - - - -	—
Sandy shale with thin beds of sandstone - - - - -	12
Sandstone - - - - -	3
Sandy shale - - - - -	5
Thickly bedded sandstone - - - - -	6
Sandy shales and sandstones, thinning away altogether in one direction, but at one spot - - - - -	3
Thickly bedded sandstone - - - - -	6 to 9
Dark shales, about - - - - -	30
Thickly bedded sandstone - - - - -	—

The base of the rock runs from the Stoney Middleton fault near Calver with a well-marked escarpment southwards through Manners Wood, whence it turns to the north, and seems to abut against the Chatsworth fault a little south of Calton Lees.

The upper boundary of the rock is seen in the river below Baslow, and can be again fixed very nearly from Buston Wood to Edensor Inn; the rest of the line is conjectural.

We will now come to the line of fault which has been drawn through this rock from Brambley to Bow Cross. The ridge to the east of Brambley is formed by the outcrop of the Yoredale Grit, and from the top of it the ground slopes down to the bottom of Brambley Dalc. The steep slope on the eastern side of this valley is shale, and on the top is the escarpment of apparently a second and higher sandstone bed. Looking at this ground alone, we should not hesitate to say that the Yoredale Grit is here made up of two sandstones, with a thick mass of shale between. If we try to trace out the lower bed, however, we find that it is not continuous, but ends off suddenly, both on each side of the valley south-east of Hassop, and again at Birchall Lodge; while south of Bow Cross we have no sign of a double escarpment. This leads to think that the more westerly of the two escarpments is caused by the Yoredale Grit being thrown in again by a fault down to the west, and this fault we draw through the points where that escarpment ceases. If we further examine the sections along the line of fault, we find a great deal of disturbance where it crosses the Derwent; at the Brickkiln, marked on the map a mile west of Baslow, the beds are tilted at high angles; and in the brook, a little further to the south, are actually on end. This evidence is therefore pretty satisfactory.

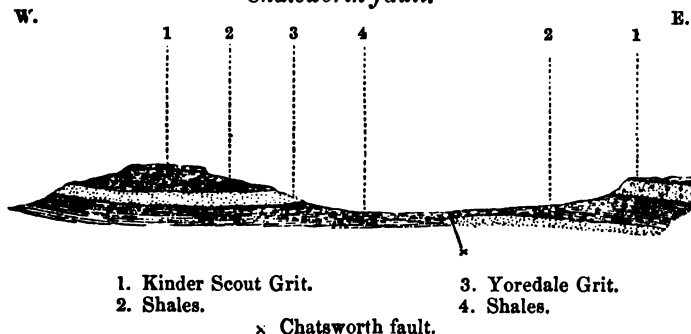
The two outliers of the Kinder Scout Grit mentioned are found on Baslow Bar and Lees Moor. The first lies to the south of the Stoney Middleton fault, and furnished good evidence for the line of the fault by the way in which its escarpment ended, both to the north-west and south-east. The rock is a finely grained, massive sandstone, and the base is well shown in Yeld Wood, where the stone forms a cliff above the underlying shales: the large masses of freshly fallen rock that lie about show that the escarpment is being gradually carried back as the cliff is undermined by the springs which burst out plentifully at its base. The rock on Lees Moor, which is most likely Kinder Scout Grit, is coarse and rather massive, with here and there a few quartz pebbles.

* *A Delineation of the Strata of Derbyshire.* By White Watson, p. 28.

We may now notice the Chatsworth fault, which ranges through Chatsworth down to Rowsley. A section across the valley anywhere between Chatsworth and Rowsley would run as in Fig. 27, and from it we see at a glance that some fault is needed along the valley.

Fig. 27.

Section across the Valley of the Derwent to show the necessity for the Chatsworth fault.



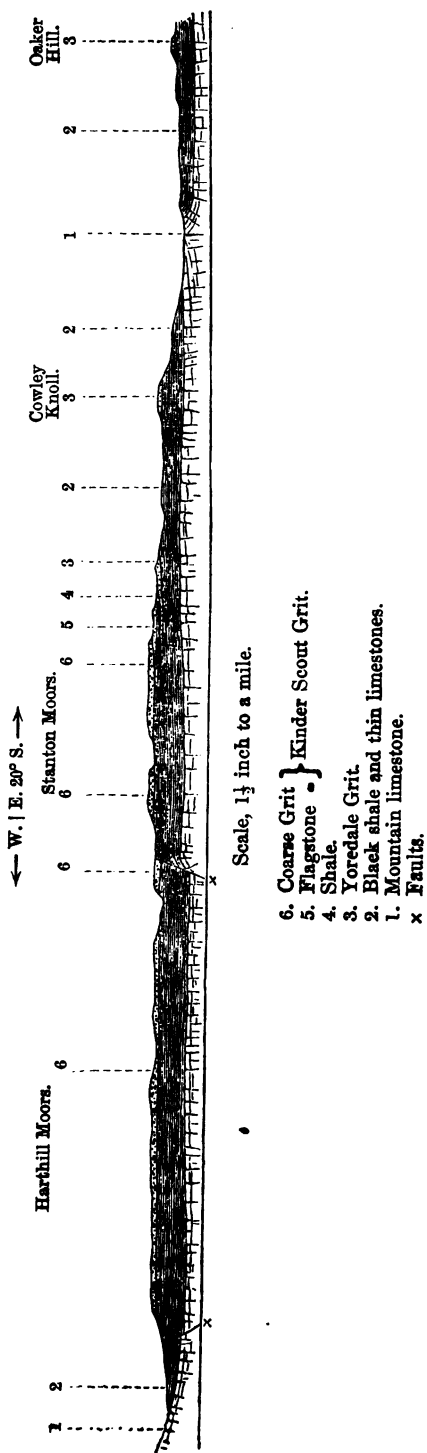
We shall describe by-and-by, in the account of district 12, the way in which this fault accounts for the absence of the Kinder Scout Grit in Chatsworth gardens. We also find tilted beds, near what we suppose to be the line of the fault in the Derwent, half a mile north-east of Rowsley Station. To the south of this we have no evidence, but it seems likely that the fault dies out. For this it will be seen that though we have every reason to believe that a fault does run along the valley, the evidence for fixing its exact position is very meagre.

(10.) *Stanton Moor and its neighbourhood.*

South of the Wye and west of the Derwent there is a sort of bay in the limestone, in which stands the village of Stanton. This is occupied by Yoredale Rocks capped by outliers of Kinder Scout Grit. The Mountain Limestone peeps up in a very small inlier near the hamlet of Oaker. The Kinder Scout Grit, which had fallen off so vastly in character about Stoney Middleton and Chatsworth, has here recovered itself. In parts it resembles very closely the Kinder Scout Grit on the east of the Derwent, while the coarser portions of it are strikingly similar to the typical grit of Kinder Scout, weathering like that rock into huge detached masses that stand up like cromlechs, for which they are often taken, on the level surface of the rock, forming very conspicuous and unique features in the landscape. On the east a belt of Yoredale Grit is found below the Kinder bed, only slight traces of a corresponding outcrop were seen on the west.

The Stanton Outlier.—The northern portion of Stanton Moor consists of a thickly bedded sandstone, not very coarse, largely quarried for grindstones and building. The southern portion is mainly a coarse grit, forming at the back of Birchover and in the castellated hill known as Rowter Rocks a particularly fine escarpment of weathered crags. To the north of Birchover is a queer horse-shoe shaped hollow or bay, bounded on the south-east by a cliff of rock, and on the opposite or north-west side by an escarpment gradually dwindling from the aforesaid cliff, while the south-west end is open and shows no feature on the surface of the ground. The base of the Kinder Grit must here run back

Fig. 28.
Section from the Valley of the Derwent across the Kinder Scout Grit of Stanton and Harthill Moors.



up hill beneath the cliffs: this is due to a westerly dip. A long tongue of flaggy sandstone to the south-east of Barn Farm has been mapped as Kinder Grit; we took it to be a "chance bed" lying at the base of the coarse rock and thinning away to the north and west. At the village of Stanton a fault running north-west and south-east crosses the outlier, the evidence for which is satisfactorily given by the shifting on both sides of the base of the Kinder Scout Grit.

Between the western escarpment of the outlier just described and the road from Winster to Bakewell is found a patch of coarse rock exactly like that of Stanton Moor and Birchover, which must be Kinder Scout Grit, thrown down on the west by a fault. The evidence for this fault is as follows: an escarpment may be traced as far north as the lodge south-west of Stanton House, and there ends off abruptly; in a brick pit three quarters of a mile south by west of this point the Yoredale shales have a reversed dip tending to carry them against the grit hard by, as shown in the section, Fig. 28. A quarter of a mile further south the escarpment again seems to end off, and a little beyond a knoll of coarse grit, forming Bradley Rocks, is brought at Brimsbury House against the finely grained sandstones of the Yoredale Grit.

From this fault at Brimsbury House a belt of Yoredale Grit may be traced beneath the southern and eastern escarpments of the Kinder Scout Grit. In the wood on the south of Cowley Knoll Lane there are two sandstones with a thick bed of shale between, and hence northwards the sandstone was seen here and there, best of all in Hilcar Wood.

A pointed hill called Peak Tor, between Stanton and Rowsley, is capped by a coarse red massive grit, in parts a conglomerate, below which there are traces of a sandstone escarpment. It seems most likely that these two rocks are Kinder Scout and Yoredale Grit, and a fault has been drawn to explain the position of the former at so much lower a level than the plateau of the same rock to the south. To the west of Peak Tor, though we seldom see any rock, a fair feature is found which probably marks the outcrop of the Yoredale Grit. This escarpment, however, gets gradually fainter and dies away in about half a mile, and the sandstone therefore probably thins out.

Harthill Moor Outlier.—The Kinder Scout Grit is along the eastern escarpment a particularly fine rock, weathering into great Tors, which make picturesque and romantic features in the landscape, and are associated with popular legends of Robin Hood. The lower boundary of the grit is well marked, it is broken in four places by faults which are very distinct, with the exception of that near Bury Cliff, which is rendered somewhat doubtful by drift-clay.

On the north side of the outlier the shales beneath the Kinder Scout Grit contain a bed of sandstone, which may represent the Yoredale Grit; it was not persistent enough to allow of its being laid down on the map.

Inlier of Mountain Limestone north-west of Oaker.—This little patch has been just laid bare by the denudation of the brook. On the north the beds pass with a gentle dip below the Yoredale Shales. On the east and south the limestone plunges down at angles of from 40° to 60° . There is a second smaller patch, seemingly bounded on the north side by a fault. The rock contained a little chert and many fossils.

Oaker Hill.—The sharp knoll has been left standing an isolated peak in the broad valley of the Derwent by some freak of denudation. It is capped by one, perhaps two, very small outliers of sandstone, representing most likely the Yoredale Grit. The south-western side is covered with landslips, and some sandstone, that has been quarried low down on the hill, has probably been brought down by one of these slips.

(11.) *The Millstone Grit, Yoredale Rocks, and Mountain Limestone to the east of the Valley of the Derwent, from Hathersage Moor on the north to Ambergate on the south.*

We will now return to the neighbourhood of Hathersage, and take in hand a large tract of country, lying to the east of the Derwent valley, and reaching from Hathersage Moor on the north to Ambergate on the south.

The structure of the northern part of this district is simple enough.

On the eastern side of the river Derwent the ground rises steeply, and from the top of the slope falls away gently to the east. As we should infer from this the dip of the beds is steadily in the same direction, and as we go east from the river we cross first a belt of Yoredale rocks, then the outcrops of the several Millstone Grits, and at an average distance of two miles reach the boundary of the Lower Coal-measures. See Horizontal Sections, sheets 70 and 18.

Southwards from the latitude of Beeley the lie of the beds is complicated by an anticlinal ranging north-north-west through Ashover. Along the western part of the district we find the same steady dip as before, and ascending the eastern slope of the Derwent valley we cross in the same way, one by one, the outcrops of the Yoredale beds, the Kinder Scout grit, and the Third Grit. On reaching the top of the slope, however, instead of finding as before that the ground falls away and the beds continue to dip to the east, we step on to a broad plateau, spreading over Beeley, Darley, and Tansley moors, and, as we should expect from the shape of the ground, discover that the beds flatten, fall into a basin shape, and finally turn up to the east. From the eastern margin of the plateau we descend into the deep valley of the upper part of the river Amber, and the fall of the ground and the easterly rise of the beds bring out to day again the several members of the Millstone and Yoredale groups, and lay bare at the bottom of the valley an inlier of Mountain Limestone. On the eastern side of the valley the dip is reversed, and we again cross in our ascent the same group of beds as on the western side, and finally reach the Coal Measures. The lie of the beds is shown in sections Nos. 4 and 5, Plate I. Northwards from Ashover there is a complete series of the beds between the Mountain-limestone and the Lower Coal-measures, each member coming on over the underlying one by a natural superposition; but from Northedge southwards the eastern boundary of the Millstone Grit is formed by a succession of faults, which bring different members of that subformation against the Lower Coal-measures.

At the extreme south of the district is the Mountain Limestone inlier of Crich Hill, brought up partly by faults and partly by a dome-shaped elevation of the beds.

Of the rocks themselves we note that the Yoredale Grit dies away, or becomes so irregular in its occurrence as not to be traceable, for some distance north and south of Darley, but sets in again near Matlock. The Kinder Scout Grit, which in Chatsworth Park had very nearly thinned away, swells out again rapidly southwards, and is again a very striking rock, 150 to 200 feet thick. The Third Grit in the southern part of the district loses the very striking form it wore from Crow Chine down to Chatsworth, and is a reddish compact sandstone, never very coarse. The Second Grit is for the most part represented by a single bed of sandstone.

The horizontal sections, sheets 70 and 18 of the Geological Survey, cross this country, the one near Grindleford and the other near Chatsworth, and give us the following thickness of the beds :—

						Sect. 70. Feet.	Sect. 18. Feet.
Rough Rock	-	-	-	-	-	100	150
Shales	-	-	-	-	-	160	200
Second Grit	-	-	-	-	-	40	50
Shales	-	-	-	-	-	100	140
Third Grit	-	-	-	-	-	200	200
Shales and sandstones	-	-	-	-	-	470	240
Kinder Scout Grit	-	-	-	-	-	—	—

The Second Grit we shall see is often much thinner, and here and there thicker, than at these spots; the other thicknesses are most likely fair averages for the respective neighbourhoods.

It will be handy first of all to consider the country as far south as Swine Sty,* and we will begin with the Third Grit, whose escarpment is by far the most striking feature in this part of the country.

The rock is massive, well jointed, and coarse, but less so than on Crow Chine, and of a dark red colour. It is largely quarried for building and millstones, the latter being used for oats, beans, and the coarse kinds of grinding, but not for wheat. The loose blocks lying below the escarpment called "day-stones," are also worked up for these purposes.

Our account of this bed was carried, in the description of district 8, up to Fox House, and we mentioned that at that spot the rock was shifted towards the west by a fault. To the south of this fault the escarpment sets in again at the northern end of Booths Edge, and ranges thence southwards along Froggatt, Curbar, and Baslow Edges. The description already given of Crow Chine and Stanage Edge applies equally well to the range of cliff edges we are now looking at, and on the slope below we have a still larger amount of tumbled rubbish, hiding the junction of the grit with the underlying shales, and reaching all down the steep to the alluvial flat. The following details deserve notice. On Booths Edge the grit is rather more felspathic than usual, and stained sometimes by red ferruginous matter. Some is very coarse with pebbles of quartz and felspar, the latter being mostly small. The following joints were measured here:—

W. 50° N. }	W. 42° N. }	W. 60° N. }
W. 20° S. }	— — }	W. 15° S. }

White Watson mentions (*Delineation of the Strata of Derbyshire*, p. 25) that sheep pastured on the Third Grit in the neighbourhood of Hathersage "produce the wool most esteemed in the country." This hint is worth attention; for, if there be any truth in the statement, it might point out a way of turning to some good account the land of these moorlands. Above Booths Edge the rock forms a double escarpment, the higher ridge being marked on the map as Over Owler Tor, but whether this is owing to a band of shale dividing the grit into two parts, or to a fault repeating the bed, or is a mere accident, we are unable to say on account of a want of sections. Just above Upper Padley there is a small oval piece of the grit let down by a little fault, ranging nearly north-west and south-east, and throwing down to the south-west, the evidence for which was the shifting of the base of the escarpment. The displacements on Padley Common, where the line of Hucklow Edge Lode would, if produced, cut the escarpment, have been already noticed. Of the three branches into which this fault seems to split, the two more northerly, besides shifting the Third Grit, are also clearly seen to cut the escarpment of the Rough Rock further to the east. The branch ranging towards the south-east not only shifts both these escarpments, but is also proved on the flat ground between them by the apparent shifting of the upper boundary of the Third Grit on Stoke Flat. Near here is a very singular opening in the rock, which, though perhaps partly artificial, is very difficult to account for; it lies about one-eighth of a mile west of the "S" in the words Stoke Flats on the map, and is a fissure some 3 or 4 feet wide, reaching down to a depth of 10 feet in places, perhaps more, for there is rubbish in the bottom, running nearly in a straight line N.N.E. and S.S.W., and bounded on either side by a natural joint of the rock. It is hard to see how it could have been formed naturally, and, if artificial, it is like nothing so much as the workings on the "back" of a mineral lode. We could learn nothing of its history in the neighbourhood. It is useful as it shows the junction of the grit with the overlying shales. Southwards from this point there is nothing along the line of this rock worth special notice till we reach the spot where it is cut by the Stoney Middleton fault. This fault seems to have here but a small throw, and to be on the point of dying out; there are several small breaks running nearly parallel to it, but the details will be best understood by a reference to the map.

The junction of the Third Grit with the overlying shales, though nowhere

* In Map 82 S.W.

actually seen, except in the cleft near Stoke Flat described above, can be traced with more or less certainty by the shape and nature of the ground. The upper boundary seems to be faulted just above the words Curbar Bar* on the map. The junction between the grit and the overlying shales is there all but seen, and the line makes then a very sudden and awkward bend down into the valley of Sandy Brook. The fault thus hinted at helps us out of some difficulties, to be described shortly, in the upper part of Barbrook.

We will now go back to the northern end of our district and take in hand the Second Grit and the Rough Rock.

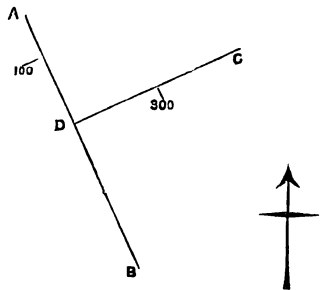
The former is in this part of the country very obscure and also very changeable, sometimes being nearly 100 feet thick and sometimes very thin, at one spot consisting of two sandstones with shales between, at another of only a single sandstone. The Rough Rock is a coarse gritstone, often of a deep red colour.

In the neighbourhood of Longshaw Lodge the evidence for the Second Grit is as follows. If you walk from the Fox House and Grindleford Bridge Road towards Longshaw Lodge, starting at the point where the Hollow gate path comes into the road, you have first a quarry in the Third Grit which must be near the top of the rock, for a little higher up the hill, about half way between the quarry and the lake, the ground is marshy indicating shale, and shales are actually seen on the same horizon as the marshy ground in a brook a little to the north-east. Then, still higher up the slope, about as far again on the other side of the lake, you come to a sandstone which has been quarried on the path from Longshaw Lodge. This then must be the Second Grit. Above this the Rough Rock forms a clear escarpment at the back of Longshaw Lodge.

Having now determined the names and position of the three grits at this spot, we are in a position to give the detailed evidence of the fault through Fox House, the existence of which we already inferred from general considerations (p.72). The band of Second Grit which we found below Longshaw Lodge is seen, if followed to the north-east, to abut against a wall of Third Grit, running parallel and close to the road from Fox House to Burbage Bridge. This requires a fault throwing up to the north and ranging in a north-westerly and south-easterly direction. Further, where the line of this fault produced cuts the outcrop of the Rough Rock, we find the escarpment of that bed to end off suddenly, and have in its place on the north side of the fault beds of sandstone and shale, which we have already stated belong most likely to the Lower Coal Measures. These two observations give us the line of the fault with great accuracy, but a difficulty occurs about its throw; for while in the one case it brings Second Grit on the south-west against Third Grit on the north-east, thus throwing up to the north-east, in the other case it brings Rough Rock on the south-west against Coal Measures on the north-east, thus throwing down to the north-east. This seeming contradiction is, however, explained by the fact that between the two points just mentioned a fault runs nearly at right angles to the Fox

House fault, having a down throw to the south-east larger than the up throw of the latter to the north-east. In the angle, therefore, between the two faults, there will be a down throw equal to the difference of the throws of the two faults. This we may explain better by a diagram. Let AB, in fig. 29, be the Fox House fault throwing down, say 100 feet, to the west; and CD, the other fault, throwing down, say 300 feet, to the south: then it is clear that, while the beds in the angle ADC are 100 feet higher than those to the west of the line AD, the beds in the angle CDB will be 200 feet lower than those to the west of the line BD, and so the fault AB will seem to have changed the direction of its throw.

Fig. 29.—Diagram to explain the Change in the Direction of the Throw of a Fault.



About half way between Fox House and Burbage Bridge a powerful spring, never known to fail in the driest weather, breaks out by the road side. Though not exactly on the line of the fault we have just been describing, it is probably

* In Map 81 S.E.

in some way connected with it. Mr. Sorby finds that the winter and summer temperatures of the water of this spring are 46° and $45\frac{1}{2}^{\circ}$ Fahr. respectively;* and this uniformity of temperature makes it likely that the source is very deeply seated.

A fault ranging through Wooden Pole† must next be described. We have already seen that the belt of Second Grit below Longshaw Lodge is cut off on the north by the Fox House fault, and if we attempt to trace it to the south we find it again fail in this direction also, for in the brook which bounds Sheffield Plantation on the north-east, we find shale, where the sandstone would naturally cross the brook. This calls for a fault. To determine the direction and throw of the fault, we notice that the escarpment of the Rough Rock, behind Longshaw Lodge, ends off suddenly at a spot immediately below and south of Wooden Pole, and sets in again at the junction of the roads on Totley Moss.‡ A line joining these two points on the escarpment of the Rough Rock passes, when produced, a little to the north of Sheffield Plantation, where a fault is wanted. This gives a fault ranging north-west and south-east, with an upthrow to the south-west.

On the south of this fault the Second Grit is found forming a good escarpment. It is largely quarried for flags and building stone at the Slate Quarries marked on the map. From a rough measurement we estimated its thickness there at not less than 80 feet. The escarpment dwindles away towards the northernmost branch of the Hucklow Edge lode. There is no evidence between this and the second branch; but between the second and third branches there is a slight feature, generally parallel to the escarpment of the Rough Rock, which is supposed to mark the outcrop of the Second Grit. After crossing this last fault there is a corresponding feature, on which we find, just about the edge of Map 81 N.E., a quarry in sandstone. Thence this sandstone bed can be traced along the hill side to a spot below Swine Sty.

Below this bed of Second Grit there is a second well-marked feature, commencing immediately to the south of the brook that flows by the Masons' Arms. This bank has much sandstone strewn about on it, and on following it south you find, just east of the highest point of Curbar Edge,§ good indications of sandstone in place, while the shales above and below are seen on either side. This sandstone is last seen on the pathway due east of the "E" of the words "Curbar Edge;"‡ and this spot is evidently just at the bottom of the bed, from the shaly nature of the soil. A little beyond this point the fault, already mentioned as affecting the upper boundary of the Third Grit, seems to range across the valley, and bring about some such shifting of the beds as is laid down on the map. The lower Second Grit may be seen at one spot to form a bank on the south side of Sandyford Brook, the stream running on the top of the sandstone and the northern bank being formed of the overlying shales. This bed, however, seems soon to die away to the south. The Rough Rock calls for no very particular notice. It is coarse, and of a red colour, especially at the back of Longshaw Lodge, and is easily traceable by the excellent escarpment which it makes. Its thickness on White Edge, where the Horizontal Section, sheet 70, crosses, is probably about 100 feet. Below Ramsley Lodge§ it seems for a while to be much thinner, but it soon swells out again and forms a very bold and rugged ridge to the south of Nelson's monument.

Having now brought up all our lines to the same quarter, namely to the latitude of Swine Sty, we will continue our account of the various beds in order, beginning at the top.

From Swine Sty the Rough Rock forms a very good escarpment, in places a cliff, in places a well-marked bank, along the side of East Moor, and then bending to the east ranges along the north side of the Hipper valley down to the bend in the brook, and thence, after being shifted by a small fault, up the south-east side of the stream, forming the base of a good escarpment of massive, coarse red grit, which runs along Stone Edge to a point a little east of Bramley Fall Quarry, where it stops suddenly, as if cut off by a fault. We

* Paper read before the Geological and Polytechnic Society of Yorkshire, Dec. 14th, 1859.

† In Map 82 N.W.

‡ In Map 81 S.E.

§ In Map 82 S.W.

shall see below that a little to the south of this point the Second and Third Grits are brought against Lower Coal-measures by a fault whose line produced runs up to the spot where the escarpment ends off. This fault we will call the Stone Edge fault. At a spot S.E. by E. from Chatsworth a curious longitudinal fault occurs, which cuts the escarpment three times within the distance of a mile, throwing up a lenticular piece of the underlying shale between the two southern sections, the down throw being on the south-west.

Here for the present we leave the Rough Rock, and take up the line of the Second Grit. From the broken ground beneath Swine Sty this rock is not seen until we reach Barbrook. Below the escarpment of the Rough Rock this stream runs for a while in shale, and then cuts down to a sandstone bed, along the top of which it flows for some little distance, the sandstone itself occupying barely more than the bed of the stream. After passing, however, a sharp turn in the brook we find ourselves again on shale, overlying which in the eastern bank is a sandstone bed reaching some way up the hill side. This sandstone we believe to be the same bed as we found higher up in the bed of the brook, but thrown up by a fault, and the fault which we have already found breaking through the upper boundary of the Third Grit, and which came in useful to explain the difficulties of the ground below Swine Sty, runs across just to this very spot and again helps us. Below this point the stream soon cuts down to the shale beneath the Second Grit, which are seen in many places, thrown into folds and broken by an anticlinal ranging along the valley. It runs in these beds as far as the road, where it cuts down to the Third Grit, the junction being well shown near the bridge and for a distance of about a quarter of a mile north-westwards from it. To return to the Second Grit, the rock, after having been thrown out of Barbrook by the Swine Sty fault, is seen for a short distance forming the steep hillside that bounds the brook on the east; we have no further evidence for it till we come to the top of the hill immediately west of Nelson's Monument; from this point it makes a well-marked feature down to Robin Hood Inn. A coal lying on the top of the sandstone has once been worked here. The same sandstone and coal may be traced towards the North Park gate. Between the north and south Park gates there is no evidence, unless the two lines of ponds be taken to mark the outcrops of two bands of shale, and the falling ground between them that of the Second Grit. South of the southern Park gate is a ridge, beginning at Beeley Moor End and about half a mile long, with sandstone lying about on it, which is doubtless Second Grit. From the end of this ridge there is no evidence till a point 30 chains south-west of the Trigonometrical station of 1,225 feet, where sandstone is seen in the bank above the brook. Thence the rock is unseen till the cross roads S.S.W. of the Trigonometrical station of 1,213 feet, from which point a well-marked bank of sandstone runs to Harwood Grange. Immediately to the west of this house the boundaries are a little uncertain, but the rock crops out on the road side just above the Grange; and in the brook Hipper its top is seen immediately above the bridge and the bottom immediately below, so that the bed is here only a few feet thick. Eastwards from this point we have no trace of the Second Grit for the distance of one mile; but, whether the bed dies away altogether for a while, or whether it is hidden by rubbish from above, we do not know; either supposition is likely enough when we consider the small thickness to which it has come down. We find this rock setting in again about Stone Hay under the form of two irregular sandstone beds parted by shale. The upper sandstone is seen in the ravine formed by the brook running north from Stone Hay, at the top of a cliff, and comes down to the brook where the path crosses it; its base is not well shown, but must run southwards parallel to Stone Edge. To the south this bed must die out before reaching the high road; to the north it may be traced as far as the Hipper, where it abuts against a fault. Between this fault and Harwood Grange no trace of the rock was found, as we said above. The under sandstone forms the hill between Stone Hay and Spite Winter; and, a little to the east of the latter, is brought against Coal-measures by the Stone Edge fault. Towards the west we find at the farmhouse, on the lane from Spite Winter to the Cupola, a stone pit showing the rock dipping

* In Map 81 S.E.

† In Map 82 S.W.

apparently to the north-east, and the hill above the Cupola is strewn with fragments of a like sandstone; the rock is again seen in a quarry just below the "s" of the words "Waiton Lees," and again beneath Stone Hay at the foot of a little waterfall. This lower bed seems, however, soon to die away altogether towards the north. On the top of this sandstone, or a little above, there seems to be a thin coal with a Ganister floor; an old pit at the top of the first stroke of the letter "H" in the words "Yew Field House" was most likely sunk to it, and it seems to have been worked also about half a mile to the west of this spot.

We now come to the Third Grit, which rising from the Barbrook valley forms a well-marked and bold escarpment about Chatsworth.

The upper boundary of this bed is well given, as we have already mentioned, in Barbrook. Thence southwards it is for a while indistinct, but for some distance both to the north and south of Robin Hood's Inn a coal lying on the top of the grit has been worked, and gives us the line exactly. The same coal has again been gotten from the South Park Gate to above Hill Bank Plantation; we were told that it was here 1 ft. 9 in. thick. Hence the upper boundary can be traced to the words Millstone Sich on the map. The line here bends sharply to the south, and after running in that direction for more than a mile returns as sharply almost to the point from which it started, enclosing a long narrow bay of the overlying shales. Shale was actually seen in this bay on the flat ground of Darley Flash, and the whole is covered with a stiff clay, whether the washing of shale or a distinct bed of clay we do not know, but it is pretty clean, and such pebbles as it does now and then contain are all of sandstone. The exact limits of this bay of shale are uncertain. From the north-eastern corner of this bay the upper boundary strikes across the moor till it abuts against a fault one-eighth of a mile south-east of Harwood Grange. A small faulted outlier of the Third Grit lies on the north side of this throw, due south of Harwood Grange, the rock of which was seen in a pit eight chains south-west of the grange. This fault forms the boundary as far as the "R" of the word "River," whence eastwards the boundary is for a while a natural one running nearly parallel to the Hipper a short distance to the north of the stream. The rock is seen in the brook below the house, and lower down the channel cuts to it through the overlying shales, and the water runs for a while on the top of the bed. In the shale bank, nor far below the ford, is a bed of coal seven inches thick resting on clay of which three feet are seen; there is here a lower bed of coal, which must be very close to the top of the Third Grit, and lower down, below the junction of the two branches of the stream, a clay is found in its bed which is doubtless the same underclay as is seen above. One mile and an eighth east of Harwood Grange the boundary we are tracing is supposed to abut against a fault by which the rock is shifted southwards, and its top may be traced by the shape of the ground to Spite Winter Plantation, where it abuts against the Stone Edge fault, which we have already seen breaks through the escarpment of the Rough Rock near Bramley Fall quarry, cuts off the Second Grit east of Spite Winter, and now in like manner is found to stop off the line of the Third Grit. The coal lying on the Third Grit was seen in some old workings one mile and a quarter east of Buntingford Toll Gate; it was there parted from the rock by three feet of underclay.

The junction of the grit and underlying shales was seen in the southern branch of the brook on Hell Bank Plantation above Beeley, the beds lying nearly flat; this section will be described when we come to treat in detail of the various brook courses, as we propose to do below. The escarpment, however, is throughout so well marked as to give the position of the base of the rock with great accuracy.

We will now pass to the steep slope on the eastern side of the Derwent valley, reaching from near Beeley on the north to Ambergate on the south, and formed of the combined escarpments of the Third and Kinder Scout grits.

The outcrop of the Third Grit is well marked from Hill Bank Plantation along the edges of Beeley and Darley moors as far south as the portion of Tansley Moor called Middle Fallenge. The escarpment immediately west of White Edge, a little south of the Rowsley and Chesterfield turnpike road, becomes insignificant, but is still good enough to be a guide in tracing the base of the grit by Bumper Castle to Woodbrook Head, where

is a quarry beneath which the junction of the grit and shale is all but seen. In the woods of Sydnope House, a section, in the private road close by the brook, shows the actual base. Copious streams of water issue from the joints of the rock along the line of junction with the underlying shales, giving a proof of the correctness of the method of determining the base of a sandstone underlain by shales, by springs and wet ground, when more direct evidence is lacking. From this point the escarpment is well marked as far as Middle Fallenge, where the line becomes obscure in places, but yet can be traced on up to a junction in the brook below Lea; thence there is a good escarpment to the south of Holt Wood, which runs, gradually dwindling away, to Far Barn, where it winds round and ranges north-east, still very feeble, till it strikes against the great eastern boundary fault, which will be called the Trinity Chapel fault, a quarter of a mile due west of Lindway Lane Farm. The rock is here dipping to the north-west, and abuts against Lower Coal-measure sandstones dipping east at 55° , and the evidence for this point on the fault is therefore satisfactory.

We now pass to the shales between the Third and the Kinder Scout grits. In Beeley Brook the lower boundary of these beds is fairly given, and we can trace the line across the flattish ground beneath Beeley Moor up to an actual junction seen in the Wood Brook, just beneath Whitewell Cottage. Thence the line is doubtful to Sydnope Brook, which it has been drawn to cut at the point where sandstone ceases to be seen in the stream. From here as far as the road from Farley to Matlock the line is fairly given by the shape of the ground, and then becomes uncertain. In Cuckoostone Dale there is shale immediately above Bentley Bridge, below which the stream runs on a flat, apparently the top of the underlying sandstone, with a steep bank of shale on its eastern side; at the first dam the sandstone is seen and quarried on the west of the stream, and on the east side of the dam is shale on very nearly the same level. The above seems to be the case down the line of dams, and indicates either that the boundary is a fault ranging along the valley and down to the east, which would account for the Kinder Scout and Third grits appearing to be so much nearer each other on the east of Lumsdale than on the west; or that the brook runs, and the dams have been made, just on the top of the Kinder Scout Grit. We have preferred the last supposition, as there is no further evidence for such a fault as would be required by the first. The line is now for a while uncertain, but we get a junction in Middle Fallenge brook, which runs south from Tansley Moor; and thence the line is fairly given by the shape of the ground to a little distance above the junction of the streams east of Tansley Knoll, at which point rock is seen in place in the bed of the main stream. Soon after passing this point the line becomes quite obscure, till we reach the brook between Heathy Lea and Tansley Nursery, where it can be fixed within very narrow limits. From this point the line is most uncertain as far as the word "Coppock," but shale was seen near Ferny Lea Barn. The line is then good up to Upper Holloway, where it is obscured for a short way by drift; here it seems to wind round and runs parallel to the base of the Third Grit, till it also abuts against the Trinity Chapel fault.

We will now describe the Kinder Scout Grit. We have already mentioned that there are faint traces of this bed in Barbrook on the north-east side of the Stony Middleton fault (p. 87). On the other side of that fault the rock is found in the stream by the mill in Jumble Coppice. It is a thickly bedded sandstone, not coarse. Below it are black shales, and where the dip arrow is engraved on the map some beds of these are hard and slaty from a calcareous cement, and contain *Goniatites bilinguis*; *Posidonia Gibsoni*; and *Posidonia*, sp.* From the mill the base of the grit forms a little cliff through the coppice; may be traced into the park, and seen in a quarry on the bridle road leading up to the northern Park gate. Between here and Chatsworth, however, there is nothing along the flank of the hill, in the way either of feature or sections, to indicate the outcrop of a sandstone, and the Chatsworth fault has therefore been drawn so as to cut off the grit immediately to the west of the quarry in which we last saw it. By the kindness of Mr. Cottingham the head bailiff of Chatsworth was allowed to describe to us

* Determined by Mr. Etheridge.

all the diggings that had been made for many years back in the grounds, and these seemed to show that to the north of the conservatory there was nothing but shale between the base of the Third Grit and the Derwent, and therefore that the Kinder Scout Grit must either have thinned away, or been thrown out by a fault. A little to the south-west of the conservatory, however, we came upon some very poor shaly sandstone, and from this point an escarpment, faint at first but becoming better marked southwards, can be traced. The point where this escarpment begins gives us another point on the Chatsworth fault. The sandstone is seen in the brook by the south-east wall of Chatsworth Park, where it is thin and mixed up with sandy shale; and our first impression on seeing this section was, that we had reached the point where the Upper Kinder Scout Grit which had been for long gradually dwindling down, at last died out altogether. We were mistaken. From this point southwards the rock thickens out rapidly, and again becomes a striking and important gritstone, whose line of outcrop we will now trace. The rock forms Beeley Hill and its top is fairly given in Beeley Brook, being there very near the base of the Third Grit. The underlying shales were seen in the same brook where the path crosses the stream. From the corner of Beeley Moor Plantation, to Matlock Bank the Kinder Scout Grit is a very important rock, and largely quarried for the building stone known as "Darley Dale stone." It is being used for the new church at Edensor. In a quarry at the side of the Beeley and Chesterfield Road there are beds of shale in the grit, and again in Carbrook above Stancliff, where on the brow of the hill above the escarpment is a bed of shale, and above that more sandstone reaching into the wood called Sitch Plantation. From Matlock Bank we can trace a fair under boundary into Lumsdale, where we get a visible junction with the shale below. Thence the line may be carried on with more or less exactness to the turn of the lane leading from Tansley to Ribber Farm, from which point there is a low but well-marked escarpment as far as a point above White Tor Quarry. Here the escarpment is suddenly broken off, but the rock is found making a sort of bank at the back of the house due west of High Lea Farm. We thus determine two points on a line of fault, of which more by-and-by. The bank just mentioned runs east for about three quarters of a mile, and then bends north. The base of the rock on the opposite side of the valley is at a lower level, and a fault has, therefore, been drawn along the brook throwing down to the east. Crossing the valley we find the rock at Lea Mill, and can trace a well-marked escarpment to a spot about a mile north-west of Crich Church, where, like the other lines, it swerves round and runs north-east for about a mile, till near Shook Wood it abuts against the fault which bounds Crich Hill on the west. The ground here is rather obscured by drift.

Before coming to the Yoredale Beds we must notice two outlying patches of the Kinder Scout Grit which have been thrown down by faults below the escarpment of the main mass of the rock.

The first of these lies by the roadside from Rowsley to Beeley near the farmhouse Little Rowsley. The rock, which is a coarsish grit, rather thickly bedded, may be seen in a quarry by the roadside, the beds dipping south-east at an angle of 60°. Judging from the tilted beds in the river below, the Chatsworth fault would seem to range down along the west of this mass, and to form part of its western boundary. A lode and fault which bounds the Mountain Limestone at Limekiln Plantation half a mile south of Haddon Hall, has been carried on to bound it on the west, and a fault, which is seen in the river a little lower down than Rowsley Station, ranges up along its eastern side, and seems to have thrown it down into its present position. The mineral character of the rock entitles it to be looked upon rather as Kinder Scout than as Yoredale grit. We have mapped this ground as stated, but it is possible that this piece of grit may be a very ancient landslip from the escarpment of the Kinder Scout Grit above.

The second of these patches forms the bold picturesque knoll behind which Stancliff Hall, near Darley, stands. This isolated boss of rock stands out in a most marked way upon the long shale slope which stretches from the escarpment of the Kinder Scout Grit down to the alluvial flat of the river Derwent; a group of fir trees is perched on the top, making still more noticeable what would be even by itself a marked object in the landscape. The rock, which is a thickly bedded grit, not very coarse, has been largely quarried, a

yields a most valuable stone. St. George's Hall at Liverpool is built of it. Entering the quarries we are at once struck with the extraordinarily shattered state of the rock. Huge rents traverse it from top to bottom, often many feet wide and filled in with broken masses of the rock piled one on the other in the wildest confusion. Some of these, with a very slight artificial widening here and there, have been turned into long underground galleries or grottoes, the roof being formed of large broken masses of rock firmly wedged into the cleft. The presence of the rock here may be explained in two ways. Either it has been thrown down by a fault, or it is a slip from the escarpment above. On the first supposition the escarpment running round three sides of the hill will mark a natural under boundary, while on the east the rock must be cut off by the fault. The section No. 4, plate I., shows that if this rock has been brought into its present place by a downcast fault, we must have to the east of it an upcast fault of pretty nearly the same throw. Consequently, if we adopt the first explanation, we must carry on the Chatsworth fault as far down the valley as this spot. If on the other hand we suppose this to be a slip, the manifest objection arises that we cannot see the hollow which the fall of such a mass of rock would make in the escarpment, and this view is tenable only on the hypothesis that the escarpment, at the time of the slip, reached further to the west than it now does, and has since been worn back by atmospheric action, at least as far as the back of the hole out of which the mass came. Professor Ramsay was in favour of the latter hypothesis; and even if the former be admitted, the shattered state of the rock shows that slipping must have taken place after it was brought down by a fault.

Of the Yoredale Beds, to which we come next, we may notice that from Rowley southwards to Matlock Bank there is, on the eastern flank of the Derwent valley, nothing that we can safely call Yoredale Grit, as will be seen when we come to the detailed account of the sections given by the different brooks that flow down the slope.

About Matlock Bank, however, we find some traces of an escarpment beneath the Kinder Scout Grit, and this is very clear at Wood End. In Lumsdale at no great distance below the base of that rock is found a tolerably thick sandstone, which is again seen in the stream bank between Nether Tansley and Tansley Mill. Again at the corner of the path south of Ward's End is a hard coarsish sandstone not more than thirty feet below the base of the Kinder Scout Grit, and beneath this, a little to the south, is a steep, quarried bank showing shale and interbedded sandstone, which may be traced distinctly, at a short distance beneath the Kinder Scout Grit, along the west side of Riber Hill, till at White Tor, where there are large quarries, it is thrown up by a fault already mentioned, and forms the hill escarpment to a point due east of Castle Top. A fault which bounds Crich Hill on the south seems to range up to this point, and throws down against the Yoredale Grit a little patch of rock, which from its mineral character seems to be Kinder Scout Grit. On the north-east side of this fault the Yoredale Grit forms an escarpment above Coumbs Wood, but towards the valley of Lea seems to split up into two beds, and at last die away altogether. At least we find neither feature nor sections to show its presence on the eastern side of that valley.

It is of course open to question whether the bed of sandstone we have been just describing is to be considered as the equivalent of the Lower Kinder Scout or of the Yoredale grit. As we have found the Upper Kinder Scout Grit to die away very nearly for a while and then increase so rapidly and greatly in thickness, so it is not unlikely that the Lower Kinder Scout, which has long ago died away altogether, may here set in again. And it is impossible to speak positively on the point, but this bed has everywhere that peculiar character of a system of thick sandstones interbedded with shales, which caused Farey to give to the bed which we call Yoredale Grit the expressive name of "Shale Grit." This fact we think is in favour of the view that the bed in question ought to be looked upon as the equivalent of the Yoredale Grit, and accordingly it has been so coloured on the map.

In the Moletrap mine, near Cromford Station, on the lode that runs through the words Wild Cat Tor, and lying north of the first "o" in the words "Wood House," 300 feet of shale were passed through before reaching the limestone. The top of the shaft may be some 100 feet below the base of the Yoredale Grit, so that the lowest Yoredale group will be here about 400 feet

thick. Besides galena the lode contained blende in sufficient quantity to be worth working.

Beyond the steep eastern slope of the Derwent valley, the geology of which was last described, lies the table land of Beeley, Darley and Tansley moors, beyond which is the valley of the river Amber. The table land is formed by a broad spread of the Third Grit with an outlier of the overlying shale; descending into the valley to the east of it we cross an escarpment of that rock looking east, a belt of the underlying shales, the out-crop of the Kinder grit, the Yoredale shales, and in the bottom of the valley find ourselves at Ashover on the Mountain Limestone.

We have already mentioned that the Millstone Grit of this district is bounded on the east by a large fault to which we gave the name of the Trinity Chapel fault. The base of the Third Grit abuts against this fault near Dewdale Lane Farm, and we can trace it very well in a general direction of N.W. by N. to Blakelow barn, thence feebly to Amber Hill, whence it is well shown up to Gladwin's Mark. Here the escarpment fades away for a space, but reappears beneath White Edge for a little, whence the base, though unseen, is supposed to run to the bend of the road a mile E. by S. of Bunting field toll-gate. Here the escarpment begins again to be seen, and can be clearly traced round Alice Head to Spitewinter Plantation, where it stops off abruptly, giving us evidence for a point on the Stone Edge fault.

Underneath the escarpment just described is a bed of shale, and below that the Kinder Scout Grit. This rock abuts against the eastern boundary fault above Trinity Chapel, whence northwards its escarpment is very well marked to Hodge Lane; here all signs of the base are lost, the beds being entirely covered for a great distance by sandstone detritus; but rock is found in the stream south-east of Wilkin House, and a little below the base of the rock is seen. If we now go up the brook we come, at a spot nearly due east of Wilkin House, to two well-marked features which have all the appearance of base lines running up on either side to the north-west and north-east respectively. The north-eastern line soon becomes indistinct, but the other can be pretty fairly traced to fit on with a well marked base beneath Roach Wood, which can be followed for a short way, and, then failing, has been hypothetically dotted on to join the base running up in a north-easterly direction from the east of Wilkin House. In Roach Wood is a large quarry, showing a fine rock excellently fitted for building stone, and from the dip in an old quarry a little south of the toll gate it is seen that this rock passes under the Third Grit of Moor Hall and is therefore Kinder Scout Grit.

The upper boundary of the Kinder Scout Grit is on the whole good from the Trinity Chapel fault to the long coppice near Buntingfield toll gate, where it becomes obscure.

We will now take up the base line of the Kinder, and trace it along the eastern side of the Ashover valley, where it is also very clear. From the spot in the bed of the Amber south of Wilkin House, where we last left this line, it runs up to Over Town with a fair escarpment; the rock may be seen in place at the corner of the road outside Over Town, on the west. Hence the boundary is doubtful till we come to the brook between Dryhurst and Slate House, whence it continues good to Brookhurst Mill. It then becomes obscure as far as Poor Houses,* from whence there is a good escarpment as far as the road from Ashover to Stubbinedge Hall, where the rock may be seen in place just above the turn to Dicklant, dipping at an angle of 30° to the east. If we follow the base of the rock from this point southwards we find it end off suddenly at Dicklant, but immediately south of the Amber a similar rock starts again, which from its position with respect to the Yoredale beds of the Ashover basin must be Kinder Scout Grit. This shifting of the rock forms evidence for the cross fault at Dicklant, from the south side of which the base is well marked through Milltown to Clattercoats Farm, where the rock seems to be cut off by the Trinity Chapel fault in a way that will be described hereafter.

* Between Poor Houses and Near Hill there is a triangular piece of grit let down by a couple of faults; for on the roadside, at the letter "r" of the words "Dogkennel Farm," below the base of the main mass of the grit north and south, we have a quarry in grit the beds of which dip steeply to the south.

We will now take up the upper boundary of the Kinder, which we last left at Buntingford tollgate, where it was fairly given. Immediately above Over Town this line is again pretty well marked, but thence is very uncertain till the farm north of Dryhurst, whence it is fairly given up to Birkin Lane.

We may here mention that above Over Town there is a second bed of rock, with a well-marked escarpment on the west, south, and south-east, which is considered to be an outlier of the Third Grit. The base line of this bed has been some guide to us in drawing the upper boundary of the Kinder.

From Birkin Lane eastwards all traces of the upper boundary of the Kinder cease, but it must soon strike against the Stone Edge fault, and be shifted by it to the south. Accordingly we have so mapped it, dotting on the line as far as the road from Northedge to Ashover, whence the boundary is well marked as far as the neighbourhood of Stubbinedge Hall, where it runs against the Dicklant fault.

There yet remain to be described the outcrops of the three highest grits between the Stone Edge and Trinity Chapel faults.

If we ascend from Ashover to Alton by Milken Lane we cross first the Kinder escarpment already described, and afterwards three others, which are therefore the Third, Second, and First grits. These beds are each traceable south, running so as to strike against the coal crops and sandstones of the Coal Measures to about the meridian of Little Moor, along which line the Trinity Chapel fault has been drawn, cutting them off on the east. The existence of this fault is further suggested, though its exact position is uncertain, by the enormously high dips which the beds here have of 30° , 55° , and 70° ; this also accounts for the very narrow width of the Millstone Grit series (see Sect. No. 4, Plate I.) Northwards these beds have been more or less hypothetically continued for want of better evidence to the Stone Edge fault, which, as it does not cut the Kinder escarpment, must die out to the south.

A glance at the map shows that the Trinity Chapel fault, whilst it apparently dies out northwards, increases hereabouts in its throw as we go south, for it brings successively lower and lower beds of Millstone Grit against the same coal.

In the belt of Yoredale Rocks that ranges round the flanks of the Ashover valley below the escarpment of the Kinder Scout Grit there are few sections, excepting in the valley of the Amber, in which stream we find shales and sandstones, rolling, and faulted in two places. It is possible that some sandstones, which are seen in the bed of the stream between the two faults, and which may be traced up its eastern branch as far as the latitude of Slate House, may be the equivalents of the Yoredale Grit, but as they form no continuous bed and die out southwards, we have not represented them separately on the map. To the north-west of Trinity Chapel, however, there is a bed of rock below the Kinder Scout Grit which we have mapped as Yoredale Grit. It dies out northwards about Raven Tor, in the same latitude as Matlock Bank, where the corresponding rock in the valley of the Derwent also thins away. The thickness of the Yoredale group is here between 650 and 700 feet; one of the shafts of the Gregory mine is said to have gone through 240 yards of shale before reaching the limestone.*

The mines formerly worked on to the plateau of Tansley Moor are now abandoned on account, we were told, of abundance of water. The basin-shaped lie of the beds, which prevents natural drainage either to the east or west, is the cause of this. This lie, which is so clearly pointed out by the shape of the ground, was proved in the mines. At the Gregory mine the dip was west, while at a mine called Cockwell, half a mile off, the limestone was found to dip to the east.*

In the little inlier of Mountain Limestone at the bottom, through which the river Amber has cut its way, it is interesting to notice that where the stream runs through limestone the dell is narrow and steep-sided, but that in the softer toadstone it widens, and broad alluvial flats stretch out on either side.

* Pilkington. View of the present state of Derbyshire, vol i. p. 80.

A very good section of limestone and toadstone is seen in the quarries to the south-east of Ashover. It is as follows :—

Section near Ashover.

	ft.
1. Thinly bedded limestones with nodules and irregular layers of chert. - - -	—
2. Solid, thickly-bedded, white limestone -	57
3. Yellowish ash with green specks, well-bedded in the lower part - - -	15
Toadstone - { 4. Dirty purple ash with green specks, bedded, with two thin layers of carbonate of lime (one fibrous) parallel to the beds - - -	12
5. Hard, red, very shaly ash. - - -	—

The toadstone was traversed by thin, irregular, vertical veins of carbonate of lime and siliceous. In No. 4 there were many rounded lumps of amygdaloid, chert, and limestone; the latter had a baked look, and were so excessively tough that they could only be broken with the greatest difficulty.

We will now describe shortly the sections given by the more important brook-courses in this district.

Burbage Brook rises on White Moss on the Third Grit, crosses the escarpment of that rock at Upper Burbage Bridge, and flows in the underlying shales, here of great thickness, and containing several sandstone beds, till it crosses the Fox House fault, by which the Third Grit is thrown down into its bed. There are many sections in this rock, the stream flowing on a gentle slope, because it runs for some distance on the surface of each successive sandstone bed, till we come to the head of a steep gorge into which the water makes a precipitous descent. This is evidently one of those cases of a sudden fall which occur when a brook passes from a hard on to a softer bed, and though the actual junction of the grit with the underlying shale is hidden by falling rubbish, the bases of the escarpments on both sides converge to this point, and a little way below it we find shale in the bank. Thence the brook cuts through a series of shales and sandstones like those found beneath the Third Grit in the upper part of its course, and above the Lower Mill enters on a sandstone which we have taken to be the upper part of the Kinder Scout Grit.

Barbrook.—At Nether End, Baslow, is a section in black shales beneath the Kinder Scout Grit; opposite the Toll Gate a band of sandstone supposed to represent this rock is crossed; beyond this everything is buried in a mass of tumbled blocks of Third Grit. The escarpments show that we must reach the base of this rock before Barbrook Mill, but we do not get sections showing it till the road to Curbar Bar. The brook then enters on the overlying shales, and the position of these and of the Second Grit have been described on p. 96. The base of the Rough Rock is not actually seen, and the position of its top is conjectural, though many sections are seen in the overlying Coal-measures.

Beeley Brook.—The base of the Third Grit is shown at a small waterfall in the southern branch of this stream in Hell Bank Plantation. The shales below are shown, but not their actual junction with the Kinder Scout Grit, but the rock itself is laid bare, and just below the footpath is a section in shales and sandstones beneath it, passage beds from the Grit to the Yoredale shales; thence to the end of the wood we continue on shale with a few very thin sandstone beds. After this there is no section till we come to a band of sandstone of no great thickness, but which makes a distinct feature on the hill side to the south, and may be traced to Fallenge Brook, where it is seen again. This bed is not thick enough to be taken as the representative of the Yoredale Grit, and is, moreover, further from the base of the Kinder Scout bed than the sandstones mapped as Yoredale Grit a few miles to the south. Beneath this sandstone we have shales and then sandstones, and then down to the Derwent dark shales, rolling and in places curiously contorted.

Fallenge Brook.—The farmhouse Fallenge stands on the top of the Kinder Scout Grit, the base of which is shown in the south bank of the brook, after

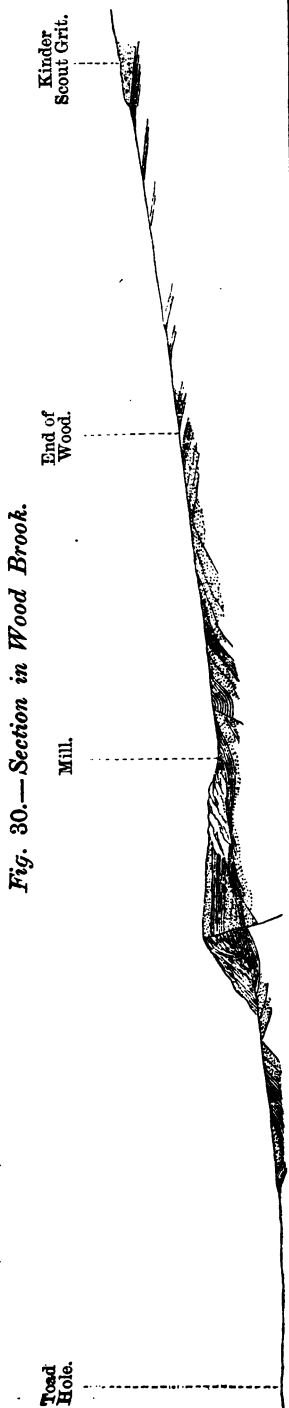


Fig. 30.—Section in Wood Brook.

which we have sections here and there in shales, often rolling, but with a general dip to the east. Just below the corner of the wood, on the south side of the brook, we find sandstone dipping N.E. at 34° ; a few feet below that blue shale, dipping E. 15° N. at 45° ; a little further still iron-stained blue shale, dipping E. a little N. at 60° ; then shale and thin sandy shale dipping E. at 60° ; some distance further shale dipping E. 10° to 20° S. at 30° . These high and rapidly changing dips are probably due to the proximity of the fault we have already described as ranging from Foxhole Wood up to this spot, and it is most likely this fault which cuts off the bed of sandstone traceable from Beeley Brook into Fallenge Brook, but not further southwards.

Wood Brook.—In this stream sections in shale and sandstone only a few feet apart give the top of the Kinder Scout Grit. This rock reaches down to the middle of Hall Dale Wood, where we enter on a mass of shale and sandstone, shown in the accompanying sketch-section Fig. 30, which may be taken as a good example of the lie and character of the Yoredale beds hereabouts.

The sandstones, though perhaps rather too low down, may be the representatives of the Yoredale Grit; they are, however, too thin and irregular, and too much disturbed to be traceable.

At Toadhole Wood Brook joins the *Sydnope Brook*, which we will now describe.

The Third Grit may be seen in the bed of the stream issuing from Flash Dam. The excellent section in Sydnope Wood, showing the base of this rock, has been already described on p. 98. Below this we have no section till the point where a road from Sydnope House crosses the dam; here we find ourselves on the Kinder Scout Grit, near the top of the bed. This rock continues till the upper end of the dam marked on the map, below which point there are sections in shale down to the mill. Below this no rock was seen.

Cuckoostone Dale Brook descends from the plateau of Third Grit on Darley Moor; the base of this grit is very clearly shown by the escarpment to be thrown up to the south by a fault running north-east from Cuckoostone Dale Farm. There are sections of the shales below the Third Grit here and there, the last of which is seen just above Bentley Bridge; below this point the brook runs on a flat, probably, as stated on p. 98, the top of the Kinder Scout Grit. Within a short distance of the bridge is a quarry in this rock within the wood, and on the opposite side of the brook fine shale is seen just above the stream; but this and the probable lie of the rocks have been already described on the page referred to. Below White Mill the stream seems to have cut a deep gully

in the gritstone, but the water is now diverted from its old channel to supply the dam. At the top of the "L" in "Lumsdale" the water falls over a cliff of grit, at the base of which are shales mixed with sandstone, and a little lower down the stream comes upon a tolerably thick bed of sandstone. This rock, as we have already mentioned, has been taken as Yoredale Grit, and, though its outcrop may be traced by the shape of the ground as far north as Matlock Bank, this is the first section we get in the bed. The lower part of this stream, called Bentley Brook, shows no sections.

The River Hipper descends from Hipper Sick across the Rough Rock, the base of which is concealed by debris. Beneath are many sections in shale. At the bridge north-east of Harwood Grange the stream cuts across the Second Grit, here only a few feet thick (see p. 96), and thence runs in shale till its junction with the stream from Millstone Sick. This branch runs at first in a gully cut in the shales below the Second Grit, which rock is seen at the top of the northern bank; it cuts lower and lower into these shales, till, due south of Harwood Grange, it reaches a bed of sandstone, which must be the Third Grit; this patch, which is not continuous with the main mass of the rock, seems to be a small inlier on the upcast side of the fault ranging along the valley. The dip soon carries the grit out of sight, but a little way below the road between the two farmhouses the stream again just cuts down to the top of the bed and runs for a little way upon it, while in the shale bank a seam of coal, a few feet above the grit, is seen. Below the junction with this branch the river Hipper cuts down to the Third Grit, a good section of which is shown where the road from Walton Lees crosses, in a cliff on the south bank. This cliff ends off where the stream bends sharply to the north, and a bank with sandstone on the top of it sets in a little distance from the opposite side of the stream. This sandstone has been already determined to be the upper bed of Second Grit, and the ending of it and of the Third Grit give evidence for the fault laid down on the map. The little brook from Stone Hay, joining the river here, runs for some distance on the top of this bed of Second Grit, which dips N. 15° E. at 10°. Further up are shales and sandstones which seem to underlie this upper Second Grit; then, still in descending order, shales, dipping N. 25° E. at 5°; then purple shales, dipping N. 28° E. at 17°; then, after an interval, dark shales; then a bed of sandstone; then a mass of shale and sandstone, over which the water falls in a little cliff at Stone Hay, which gave the following section:

	ft.	in.
Shaly sandstone and shale	-	5 0
Shale	-	2 1
Coal	-	0 11
Shale	-	0 8
Bastard ganister	-	0 7
Shale	-	0 6
Bastard ganister	-	0 4½
Shale	-	0 3
Sandstone. Lower Second Grit.		

Below the junction with this brook the river Hipper flows through shales, showing the following irregular dips. In a great bank, which the river has formed by eating away the beds, a slight dip down stream: further down the beds roll over and dip N. at 35°: still further down, below the quarry in Rough Rock on the road-side, is a dip of 70° a little E. of N. Further down, at the sharp turn in the stream, we have a mass of shales and hard sandstones, dipping N. 20° E. at 17°, and immediately after the sandstone of the Rough Rock, which reaches some considerable distance down stream. The next section is in the overlying shales below the mill. A coal lies on the top of the Rough Rock, which was once worked on Cathole Hill. Close above the Rough Rock is a sandstone of the Lower Coal-measures.

Hunger Hill Brook runs in the upper part of its course on the Third Grit, which dips to the north-east at 9°. Hunger Hill is an outlier of the overlying

shales, possibly capped by Second Grit. Just above the junction with the Hipper we have the following section :

	Feet.
Grit - - - - -	—
Shale, about - - - - -	10
Grit, about - - - - -	5
Shale - - - - -	—

Whether these are the shales below the Third Grit, or a " chance bed " of shale in that rock, we do not know.

The River Amber is formed by the junction of two brooks, one of which rises near Buntingfield toll-gate, and the other near Cullumbell. In the more westerly of these the peculiar features of the geology north of Wilkin House have been already described on p. 101. Below the base of the Kinder Scout Grit all the sections seen were in shale down to the word Prestedge, where is a bed of sandstone, and from here to the junction of the brooks we have occasional sections showing shales with interbedded sandstones. As will be seen from the dip arrows on the map the beds roll a good deal, and in Edleston Wood a fault, apparently ranging north-west, was seen. The easterly branch gives no sections till some way below the side brook from Alice Head, where we find sandstone in place; from the sandy nature of the soil we believe that this bed runs a little way higher up than the junction, but not far, because in the side brook there is a section of shale just below the road. This sandstone is found in the bank, though the stream itself runs in an underlying bed of shale as far as Brockhurst; below this point we have shales and sandstones, and at the junction of the streams we have, at least in the upper part of the steep bank, a sandstone which seems to be the same as the one seen above. The next section is at the mill, where a sandstone, apparently the same, is found in the bed of the stream dipping a little N. of E. at 15°, and immediately below the mill shale. The sandstone just mentioned we have not been able to trace any further to the south on either side of the stream, and therefore prefer to consider it a mere casual band of sandstone in the shale, of which there are so many, rather than to take it as Yoredale Grit, which it may possibly represent.

There yet remain some outliers of Millstone Grit between the fault ranging along the south-west side of Crich Hill and the river Derwent.

At Round Wood, a mile and a quarter E.S.E. from Cromford, there is a little patch of coarse grit, most likely Kinder Scout Grit, on the top of the hill; this seems to abut on the north-east against the Yoredale Grit, and points to a fault between the two down to the south-west. To the south-west of Lea Hurst is a larger patch of coarse rock, which is proved to be Kinder Scout Grit by its base line joining on with that of the main mass of the rock on the south-west of the Derwent. This is also cut off and brought against Yoredale Shales on the north-east, requiring a fault with the same throw as before. Along the line thus indicated shales are seen very much disturbed between Lea Hurst and Oxhay Wood, and when produced it runs between the limestone of Crich Hill and the sandstone of Coddington Park, which we shall shortly see is undoubtedly Third Grit. This then is the evidence for the Southern Crich fault.

The band of grit running round from Crich to Oxhay Wood is seen to be the same as the rock on the opposite side of the valley, and therefore Kinder Scout Grit. It is a massive, and in places coarsish, rock, largely quarried for building stone about Watstandwell Bridge. Its escarpment is good all round up to Oxhay Wood, near which it is much disturbed, perhaps owing to the proximity of the Southern Crich fault. Above this grit is an outlier of reddish sandstone, whose position shows it to be Third Grit.

Section No. 1, Sheet 60, crosses these beds, and gives us the following thicknesses :

Third Grit, at least	-	-	-	100
Shales	-	-	-	80 to 90
Kinder Scout Grit	-	-	-	150 to 170

We finish our account of this district with a sketch of Crich Hill

and its immediate neighbourhood. We have followed the Millstone Grit beds through a long unbroken run till they were cut off by three faults, the Trinity Chapel fault, a fault along the west side of Crich Hill, which we will call the Western Crich fault, and a fault ranging along the south-west side of Crich village and up towards Lea Hurst, which we will call the Southern Crich fault. The evidence of the Southern Crich fault has been already given, that for the Western Crich fault is as follows. The limestones on the western side of the hill are lower beds and abut against Yoredale shales, the boundary therefore must be a fault. In the bed of the stream at the bridge the shales were seen to be on end. Also between the limestone and the Kinder Scout Grit to the west there is not room for the full thickness of the Yoredale group. The fault produced northwards seems to cut off the Kinder Scout Grit near Shook Wood. In the angle between the two Crich faults a mass of Mountain Limestone has been upheaved and forms the very striking hill we are now looking at. From a distance it has the shape of an elliptical dome, but a nearer view shows that the west and south-west sides are steep and cliffy, while the eastern slope is more gentle and shades away almost imperceptibly into the flat ground beyond. This difference of outline is a sure index to the geological structure; on the first two sides the massive lower limestones plunge down steeply towards the west or south-west, and are cut off sharply against the two faults, the softer rocks on the further side of which have been carried away by denudation more largely than the hard limestone, and so the latter is left standing up in walls, the abruptness of which subaerial agents have in some degree toned down, but have not been able wholly to wipe out. On the east, however, the beds dip away regularly from the centre of the hill at a smaller angle, the massive lower limestones are overlaid by the more thinly-bedded upper portions, and these again by the Yoredale shales; and this passage step by step from the hardest to the softest rocks, rendered still more gradual by the low angle of the dip, has given rise to a more gentle slope of the surface. The Yoredale shales are in turn bounded on the east by the Trinity Chapel fault, which throws in the Rough Rock and its underlying shales. The gritstone makes a clear ridge, dipping at angles varying from 20° to 40° to the east, and is regularly overlaid by the Lower Coal Measures of the Derbyshire Coalfield.

Section No. 6, Plate I., and Horizontal Section, sheet 60, will explain the structure of this neighbourhood.

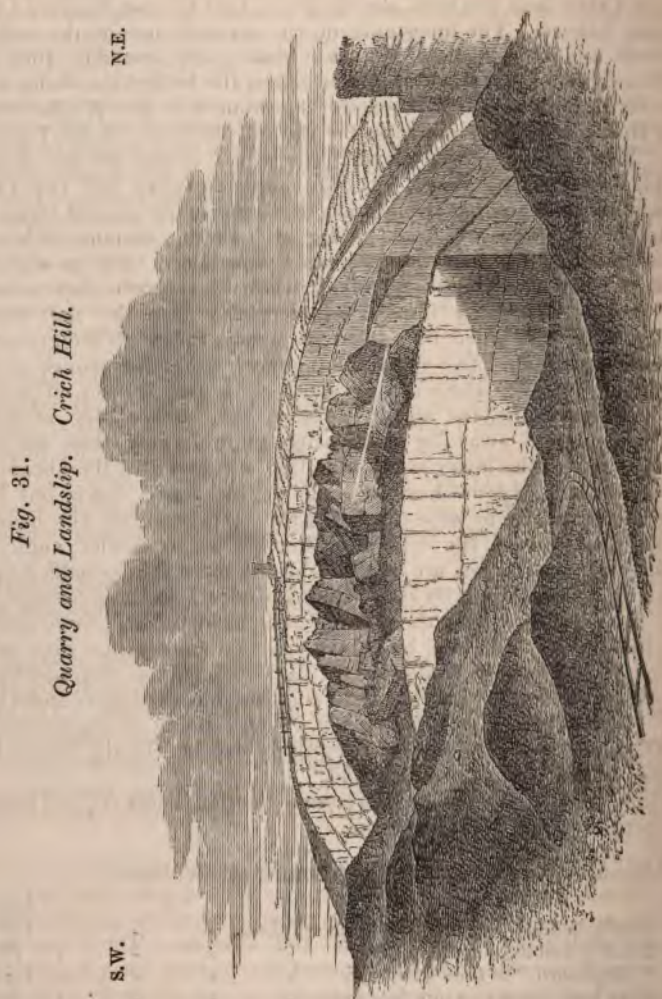
The Mountain Limestone shows the following subdivisions:

	feet.
1. Thinly bedded limestones with chert, about - - -	150
2. Thickly bedded limestone - - -	70
3. "Wayboard" of blue shaly clay - - -	1 to 3
4. Very hard massive white limestone - - -	48
5. "Wayboard" of clay - - -	—
6. Limestone - - -	100
7. Toadstone - - -	57
8. Limestone, of which there was proved in the Old End Mine, without reaching the bottom - - -	306

The first four divisions are well shown in the large quarry, south of the stand, a sketch of which is given in Fig. 31.

A little bit of the thinly bedded cherty limestone is seen at the top of the crag in the right-hand corner. Below these come the more thickly bedded limestones, No. 2, rising with the hill and forming the upper part of the face of the quarry. The clay band is shown by a black line, and below it are the massive beds

No. 4. The upper surface of this last bed is very curiously waterworn into furrows and pot holes, some of the latter being as much as two feet deep. We have already noticed that the surface of the limestone beneath a toadstone bed is sometimes marked in the same way, and supposed it to have been done by water, charged with carbonic acid, trickling along between the beds. The clay



band holds about the same position in the series as the toadstone at Ashover and the first toadstone at Matlock, but it has not in the least the look of a decomposed lava or ash. The thickness of No. 4 is given on the authority of the quarry men. The toadstone, No. 7, was reached in some mines formerly worked on the hill, details of which have been kindly furnished by Mr. E. M. Wass; from these the probable thickness of the beds No. 6 has been calculated and the thickness of the toadstone ascertained.

Seven years ago a large and very instructive landslip happened in the quarry shown on Fig. 31. The method of working is, first to remove the bed No. 2 down to the clay band, and when this has been done to quarry away the lower bed No. 4, the workings on the higher level being pushed on in advance of the

lower. A considerable breadth of the upper bed had thus been cut away, and a vertical face of it left standing at the further end, and the workmen were preparing to attack the lower limestone, when a huge mass of the upper, more than could be quarried away in several years, came down bodily upon the top floor of the quarry; when we saw it much of the fallen rock had been carried away, but what remained covered a space 150 yards long by 12 to 15 broad, and was in some places 20 yards high. The cause is obvious. It will be seen from the sketch that the beds are domed, with a small dip to the south-west and north-east, and a larger dip to the south-east, and that the quarry is worked back along the chief rise of the beds; a vertical, unsupported face of the limestone No. 2 was left resting on a wet and slippery floor which sloped down into the quarry, the rock itself is divided by long open joints running from top to bottom, and along a line of these joints the rock broke off and slid down into the hollow below. We have had occasion to notice many ancient landslips in the course of this memoir, and the present instance is a capital example of the manner in which most of them have doubtless been brought about. The jointing of the limestone has done its share to make the work more complete, and has left the cliff clean cut and nearly vertical, and this structure must be the reason why the limestone valleys are mostly so steep-sided. The ground at the back of the quarry is for some yards traversed by large cracks, and more such slips are very likely to happen; they will not be objected to by the quarrymen, provided the latter are out of the way at the time of their occurrence.

The following details respecting the mines on Crich Hill have been kindly furnished by Mr. E. M. Wass, of the Lea Lead Works, Matlock.

"In the 'Pearsons Venture,' situated on the west side of the hill, the toadstone was reached at a depth of about 80 fathoms, its thickness was 11 fathoms. This has been a most productive mine, both above and below the toadstone, but at a depth of 115 fathoms the vein became contracted and poor, and this ground being heavily watered was abandoned.

"The 'Bacchus pipe' is also on the west side of the hill; there the toadstone was found after sinking 75 fathoms, and its thickness ascertained to be 20 fathoms.

"At the 'Glory Mine,' north of Crich Stand, a much wrought and in past years very remunerative mine, the toadstone was discovered 30 fathoms from the surface, and found to be $9\frac{1}{2}$ fathoms thick. The lowest workings at this mine were 135 fathoms from day; the veins, however, diminished so materially in strength and productiveness the lower they were followed as to discourage trial requiring pumping machinery. A few men only are now making search above water mark, with but little success.

"The 'Old End Mine,' on the eastern slope of the hill and north of Crich Stand, has been explored to a greater depth than any of its neighbours. The toadstone there was arrived at in 50 fathoms, the deepest workings went down about 152 fathoms. The plant at this mine is now on sale, pumping operations having been suspended in consequence of the unfavourable appearance and gradually diminishing yield of the veins the lower they were cut."*

In these mines the veins became poorer the lower they were followed; a glance at the map of the Geological Survey shows that lodes are more numerous in the upper than in the lower beds of the limestone, and Mr. Wass in the letter quoted writes, "My own experience certainly confirms what has been frequently advanced, namely, that *as a rule* our veins are stronger and more productive in the upper than in the lower parts of the limestone." We are not in possession of facts enough to justify us in making any sweeping generalization on this subject, but

* Letter, dated March 23, 1868.

all we do know seems to point to a falling off of the contents of the lodes as soon as the lower limestones are entered.

The Yoredale beds overlying the Limestone are cut off on the east by the Trinity Chapel fault, on the downcast side of which are shale, a narrow strip of coarse grit, which we believe to be Rough Rock, and Lower Coal-measures.

The Rough Rock is a very coarse, red, crumbly gritstone; it may be well seen in several of the cuttings which carry the roads through the ridge formed by its outcrop.

We may now collect the evidence for the long line of fault we have so often spoken of as the Trinity Chapel fault.

The way in which the three upper grits are brought in succession against the Lower Coal-measures between Alton and Stubbededge Hall has been already described.

At Dicklant there is a cross fault down to the south, the effect of which seems to have to shift the main line of dislocation some way to the west, since we find none of the upper beds of the Millstone Group east of the Kinder Grit of Ashover Hay, but seem to pass at once from that rock on to Coal Measures; the fault has therefore been drawn so as to bound it on the east. The high dip of 35° at Little Clattercoats agrees with this supposition, which will also explain the stopping off of the Kinder Escarpment at Clattercoats Farm. Moreover, nowhere in the Clattercotes Brook could we find any sign of the Ashover Hay rock crossing the stream; in descending the valley from the Trinity Chapel road we started on Yoredale shales and thin sandstones dipping slightly to the west, and, after passing for a considerable distance over these beds, came at length to thicker sandstones, with intermediate beds of shale dipping to the east, and to all appearance forming part of the Lower Coal-measure series; and this combined change of dip and character we took to mark the passage across the fault. Further the escarpment of the Kinder Scout Grit terminates abruptly above Trinity Chapel, and while the dip of this bed is to the south-west we find about Mathers Grave flaggy sandstones evidently forming geologically a portion of the country stretching away to the east as far as undoubted Coal-measures, and dipping to the south-east. This has, therefore, been taken for a point on the fault. We have already mentioned (p. 98) how a little to the south of this point the Third Grit is brought against Lower Coal-measures in exactly the same manner. Still further south a belt of Rough Rock rises on the east side of the fault with a steep dip from below the Coal-measures, and this bed or the underlying shales abut against beds which from their position immediately above the Crich Limestone we know to be Yoredale shales. The fault, therefore, has been carried on between the two, but except about Shook Wood, and at the southern end of Culland Wood where the escarpment of the Rough Rock ends abruptly, its exact position is uncertain.

(12.) *The country south of the Mountain Limestone and north of the New Red Sandstone, from Ashbourne on the west to the edge of the Derbyshire Coalfield on the east.**

This tract is rudely triangular in outline, its three corners being near Ashbourne, Cromford, and Morley. The greater part of it is intermediate in height between the limestone hills on the north and the New Red

* Lying in Maps 72 N.E. and 71 N.W.

Sandstone country on the south, and is occupied by beds belonging to the lowest Yoredale Group, with an inlier of Mountain Limestone, between Bradbourn and Kniveton, and an outlier of Yoredale Grit round Kirk Ireton. To the east the Yoredale Rocks are surmounted by the Millstone Grit, the lowest bed of which comes on with a fine escarpment along a line ranging from the Black Rock, near Cromford, to Little Eaton. A plateau, sloping gently to the east, formed of this rock and capped here and there by outliers of the Third Grit, occupies the rest of the district, which is bounded on the east by a line of faults, throwing out of sight the Upper Millstone Grits and bringing in Lower Coal-measures on the further side.

The rocks then shown are as follows :

			ft.	in.	ft.	in.
Millstone Grit.	{ Third Grit, at least		-	-	100	0
	{ Shales		-	-	80	0 to 90
	{ Coal		-	-	1	5 to 1
	{ Kinder Scout Grit		-	-	150	0 to 170
Yoredale Rocks.	{ Shales		-	-	550	
	{ Yoredale Grit		-	-		
	{ Black shale and thin limestones		-	-		
	{ Mountain Limestone.		-	-		

The Third Grit is a reddish sandstone, not very coarse.

The Kinder Scout Grit varies a good deal, being sometimes very coarse and even a conglomerate, and at others a hard, closely grained gritstone, only moderately coarse. It is always very thickly bedded. The Yoredale Grit is also very changeable, at some spots perhaps wanting altogether : it is for the most part a finely grained sandstone, sometimes thickly bedded, with shale. The shales with black limestones have mostly their usual character, but here and there the limestone become so thick, pure, and numerous, as to be worth quarrying for burning into lime. Among these beds, toadstones, which are possibly intrusive, are found near Kniveton.

Section No. 1, sheet 60, crosses the northern part of this district, and the section No. 7, plate I, will explain the structure of the country further south.

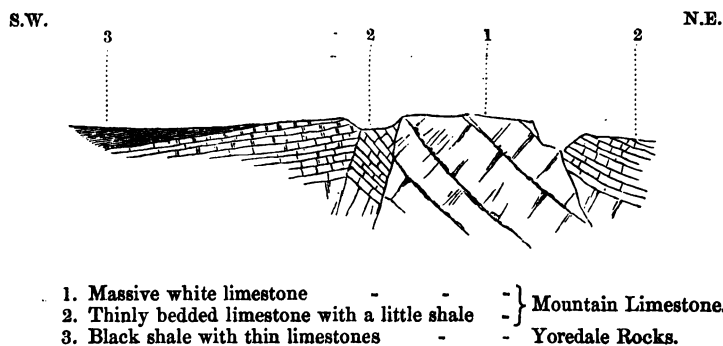
To the north of Ashbourne, though the country is much covered by drift, sections of the lowest Yoredale beds may be found in brook courses and elsewhere. One of the best is laid open by some quarries north of Fanny Bently. The limestone beds are here numerous, and run close together : they are flaggy and evenly bedded, and serve admirably for rough unmortared walls, and have been burnt for lime.

Four miles to the north-east of Ashbourne, between the villages of Bradbourn and Kniveton, is an inlier of Mountain Limestone. Drift and the contorted state of the beds make this at many points a very doubtful bit ; the conclusions arrived at will be best understood from the map and the section No. 7, Plate I., but we notice a few details of interest.

The upper beds of the limestone are thinly bedded and somewhat earthy, with partings of shale, but chert is not so plentiful in them as at some places. They were well shown in a quarry a quarter of a mile east of New House, where their junction with the underlying, thickly bedded, white limestone was laid bare ; also in quarries to the east of Bradbourn, and at other spots. On the western side of the outlier a bed of toadstone is found, whose probable place is between these thin limestones and the more massive limestones beneath. It seems, however, to be wanting on the east, for neither on the east of Wigber Low, nor at any points still further east where its outcrop ought to occur, were any traces of it found. It is, however, just possible that the toadstone, instead of directly underlying the thin limestones, is parted from them by the massive beds of Wigber Low, and is not brought out to day on the eastern part of the inlier.

The boundary of the inlier on the west is a fault, which at one spot brings the toadstone against Yoredale shales. On the north a similar juxtaposition, south-west of Lee Hall, shows the boundary to be there a fault, but as we go towards Bradbourn the fault seems to die out, and at that village the upper limestones may be seen passing regularly below the Yoredale shales. Between this village and Whin Barn the limestone is thrown into many sharp saddles, and the boundary is partly a natural one and partly formed by small faults. From Whin Barn by Over Hall Fields, round to the north of Kniveton, the ground is covered by drift, and the boundary to a great extent conjectural. Two of the faults marked at Standlow were seen in a quarry, and are shown in fig. 32.

Fig. 32.—Section at Standborn, North-east of Kniveton.



Hence the boundary for about half a mile is a natural one, broken by faults. The fault through Kniveton Wood is necessary to explain the relative position and dips of the limestone and Yoredale beds on opposite sides of the valley. The latter besides the usual thin limestones contain here some beds of chert.

Half a mile south of the village of Kniveton are two outcrops of toadstone among the Yoredale beds. The section and plan in fig. 33 will show their lie. It is clear from these that the lines marked * * * must be either faults or that the toadstones must be intrusive. Prof. Ramsay considered the latter view the safer.

The limestones interbedded with the Yoredale shales are here unusually thick and numerous. This is also the case near Over Hall Field, about a mile to the south-east, and also north of Hognaston; in both places they have been largely quarried, and at one time burnt for lime. The proportion of shale to limestone is, however, even here far too great to allow of this being now done with profit.

The outlier of Yoredale Grit round the village of Kirk Ireton requires little description. The base of the sandstone is well marked all round, except at the south-west corner, where some large knolls of drift gravel hide the boundary. There are several large quarries on the northern edge, and others a mile north of Kirk Ireton, and again on the hill called The Mountain on the south of the village.

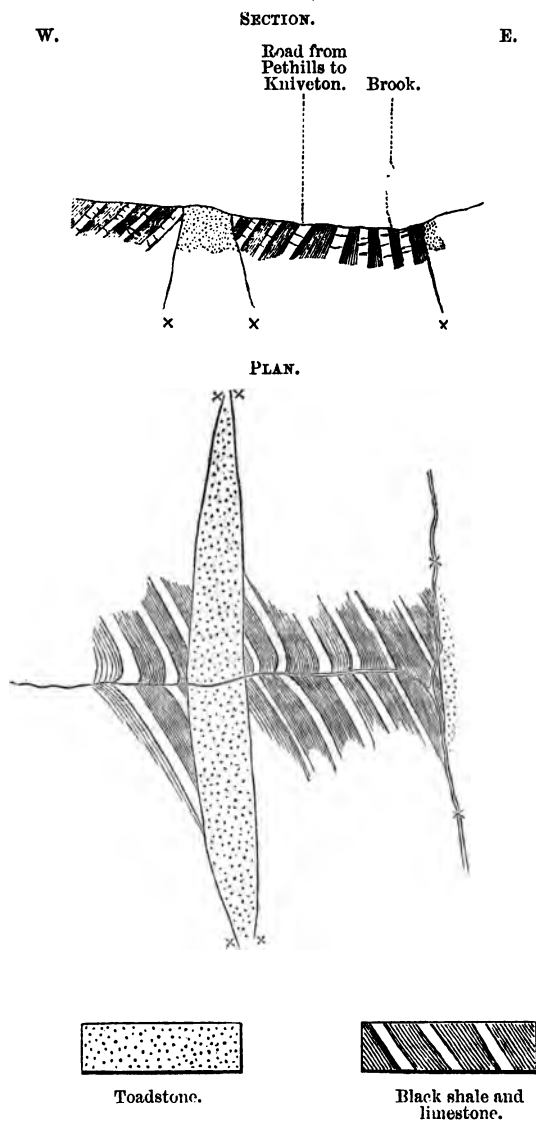
Some good sections in the Lower Yoredale beds were given by the cuttings of the Duffield and Wirksworth Railway, near the latter town. The black shales were often hard and slaty, probably owing to a calcareous cement, and contained in plenty *Goniatites* and *Aviculopecten papyraceus* of large size.

The only other section of importance before reaching the ridge formed by the Kinder Scout Grit is given by the limestone quarries, one mile south of Turn-ditch. The Yoredale limestones are here unusually numerous, thick, and close together, and are still largely quarried for wall stones and burning into lime. The "head" of shale is now getting too thick to allow of the stone being any longer raised in open work, and the quarries are struggling on by following the better beds in underground galleries driven on the dip. Owing to the absence of every one connected with the works at the time of our visits, we did not learn whether the stone possessed any qualities valuable enough to make this method of working profitable.

To the south of the country just described, the floor of carboniferous rocks,

on which the New Red Sandstone rests, has been laid bare at several spots by the denudation of the newer rocks,

Fig. 33.—Plan and Section to show the lie of the Toadstone South of Kniveton.



The largest and most notable of these inliers lies on the north side of the village of Kirk Langley. In its south-eastern part we find the ordinary black shales and limestones of the lowest Yoredale Group, but towards the north-west these beds are overlaid by a mixture of hard, closely grained sandstone and shale. The sandstones are not very like Yoredale Grit, but do in some degree resemble the Yoredale Sandstones of North Staffordshire. It is odd that representatives of these beds, which we have so long lost sight of, should turn up in so unlooked-for a way, but the likeness is strong enough to lead us

to think that the rocks in question really belong to this group, and that the area which the Yoredale Sandstones originally covered reached at least as far as this spot.

The broad spread of lower Yoredale Rocks which we have just gone over, is bounded on the east by a ridge formed by the combined escarpments of the Yoredale Grit and Kinder Scout Grit, to which we will now turn our attention.

Yoredale Grit.—A large irregularly lenticular mass of sandstones and shales reaching from Little Bole Hill on the north to Handle Wood on the south, apparently thinning out both to the north and south, so that its lower boundary merges into that of the Kinder Grit, has been taken as the representative of this rock. The shale partings are very changeable, and while at some spots we can trace as many as three lesser escarpments, at others the whole mass seems to be sandstone from top to bottom. For this reason also it has been found impossible to draw an upper boundary to the bed, the sandstone in some places seeming to run up to the base of the Kinder Grit, and in others to be parted from it by a variable band of shale. This group of beds seems also to thin away to the east for we do not find it below the escarpments of the Kinder Scout Grit in the valley of the Derwent.

Kinder Scout Grit.—Starting at Ambergate Station on the large eastern boundary fault, which we will call the Ambergate fault, we find the base of this rock running with a well-marked escarpment along the western flank of the Derwent valley: it winds round towards the Black Rock, near which it is broken by several faults. West of Alport Heights we suppose the rock to be faulted, because the escarpment we traced from Barrel Edge seems to end at The Bent, whilst above New Buildings there is a rock which we could not satisfactorily separate from the Kinder Grit. When the changeable mass of Yoredale Grit occurs below the Kinder Scout bed the base of the latter is rendered thereby somewhat uncertain, for though the latter is as a rule the coarser, both rocks consist of a mass of sandstones and shales, forming lenticular beds dovetailed into one another, so that it becomes a matter of uncertainty what ought to be considered the base of the Kinder Grit, and quite impossible to keep on an accurate geological horizon. South of Handle Wood we have again a very good base to the rock down to Camp Wood because the grit here immediately overlies shale. Between Camp Wood and Morley Moor the line is concealed by drift. The rock yields excellent building stone, and is largely quarried between Cromford and Watstandwell and south of Milford.

On the top of the Kinder Scout Grit there is generally a coal, about eighteen inches thick, which was once worked about Alderwasley and Belper.

The Third Grit is found only in outliers, of which there are four.

We will now give the evidence for the faults which bound on the east the Millstone-grit beds just described.

The Ambergate fault runs north and south from near Milford to Crich. The escarpment of the Kinder Scout Grit may be traced to Ambergate Station and the rock itself seen at several spots between there and Belper. There is, however, every reason to believe that the sandstones on the eastern flank of the valley between Ambergate and Dunge belong to the Lower Coal-measures, for they appear to pass regularly beneath beds in which known coal-seams have been worked, and in mineral character they closely resemble the rocks of the Ganister series and are totally unlike any of the Millstone Grits of the neighbourhood. For this reason a large fault down to the east must range down the valley. One point is given near Bilberry Wood, three quarters of a mile north of Ambergate, where a well-marked bank of sandstone ends off, as if by a fault, against Yoredale shales. At Ambergate Station the Kinder Grit is thrown against a thickly bedded sandstone, and the two escarpments fit so neatly into one another that the exact place of the fault seems at first sight somewhat doubtful, but on looking at the ground more carefully we note a change in feature which probably marks the position of the break. Again, along Bull Lane and southwards for about three miles a sandstone bed runs with a good escarpment along the eastern flank of the valley. The distance between the bed and the Kinder Scout Grit is too great to allow of this being the Third Grit, and its mineral character forbids our taking it for the Rough Rock, it must therefore be a Coal-measure sandstone. The line of the *Ambergate fault* runs when produced through Belper between this rock and the *Kinder Scout Grit*, and explains the relative position of the beds on either side of the

valley. This Ambergate fault may possibly be a prolongation of the Trinity Chapel fault shifted westwards by the Southern Crich fault.

The escarpments of the Bull Lane Rock and of an overlying sandstone end off along a line ranging north-west and south-east through Holbrook, and thus we get the first hint of the fault on the map, which we may call the Holbrook fault. The fault also explains how it is that the top of the Kinder Scout Grit runs down from Chevin House so sharply into the valley. Also on the south-east of Holbrook the coal and measures on the top of the Kinder Scout Grit are seen, while the rocks between Holbrook and Horsley are Lower Coal-measures. The fault has been drawn accordingly up to the point where the Kinder Scout Grit seems to end off at Coxbench.

A triangular bit of Coal-measures half a mile south-east of Milford seems to have been let in between the Holbrook fault and two others. The western one was drawn because there did not seem room for the full thickness of the Kinder Scout Grit; the exact position and direction of the other are uncertain.

A fault proved in the Coal-measures ranges S.S.E. through Horsley. Along its line produced to the south the Kinder Scout Grit ends off in a marked bank east of Horsley Castle, and a little south of Horsley Park the crop of one of the coals of the Lower Coal-measures was traced up to within five yards of a large quarry in the grit, the stone of which was shattered and fissured as if close to a large fault. So far then the evidence is good enough. Further south, however, the country is covered with Boulder Clay, and the fault has been dotted on so as to run to the east of all the known sections in Kinder Scout Grit.

(13.) *Lower Coal Measures between Oughtibridge on the North and Dore on the South.**

We have already mentioned that we can offer only an incomplete account of this tract of country, as the examination of it is not yet finished; but our description of the Lower Carboniferous rocks would not be understood without some reference to the adjoining strip of Coal Measures, and we therefore give such notes as we have been able to make.

The general section of the measures in the northern part of this area is as follows:

	ft.	in.	ft.	in.
1. Sandstone, often coarse and massive, more than	48	0		
2. Shales with a thin bed of sandstone	30	0 to 90	0	
3. { Ganister coal	1	8 to	3	0
{ Ganister and fireclay	2	6 to	6	0
{ Shale with beds of bastard ganister	90	0		
4. { Thin coal (Clay Coal of Deepcar) and fire clay				
(not always present)				
5. Sandstone	40	0 to 80	0	
{ Shales	60	0 to 80	0	
6. { Coal (Coking Coal of Deepcar),				
{ Fireclay and ganister (not always present)	2	6 to 5	0	
7. Sandstone	20	0 to 50	0	
{ Shales	60	0		
8. { Fire clay and ganister (not always present.)				
9. Sandstone	50	0		
10. Shales	100	0		
11. Sandstone	60	0		
12. { Shales	80	0		
{ Coal (not always present).				
13. Sandstone	80	0		
14. Shales	—	—		

* The whole of this district lies in Map 82 N.W. For several sections and other details we are indebted to our colleague, Mr. J. C. Ward, who bore a share in the examination of a part of it.

We have no complete section from the Ganister Coal down to the Rough Rock, and consequently there is here a gap in the series, the measures of which are unknown. But it will be recollected that the base of the Coal Measures is seen about Crawshaw (p. 60), and that we had there the following section of the lowest beds:

		ft.	in.
Lower Coal-measures.	Coal - - -	1	3
	Crawshaw sandstone - -	150	0
	Dark shale - - -	75	0
	Coal and fireclay - - -	5	0
Millstone Grit. Rough Rock.			

Whether the sandstone No. 13 is identical with the Crawshaw sandstone, or whether the Crawshaw sandstone lies below No. 13, and, if so, how far below, we do not know.

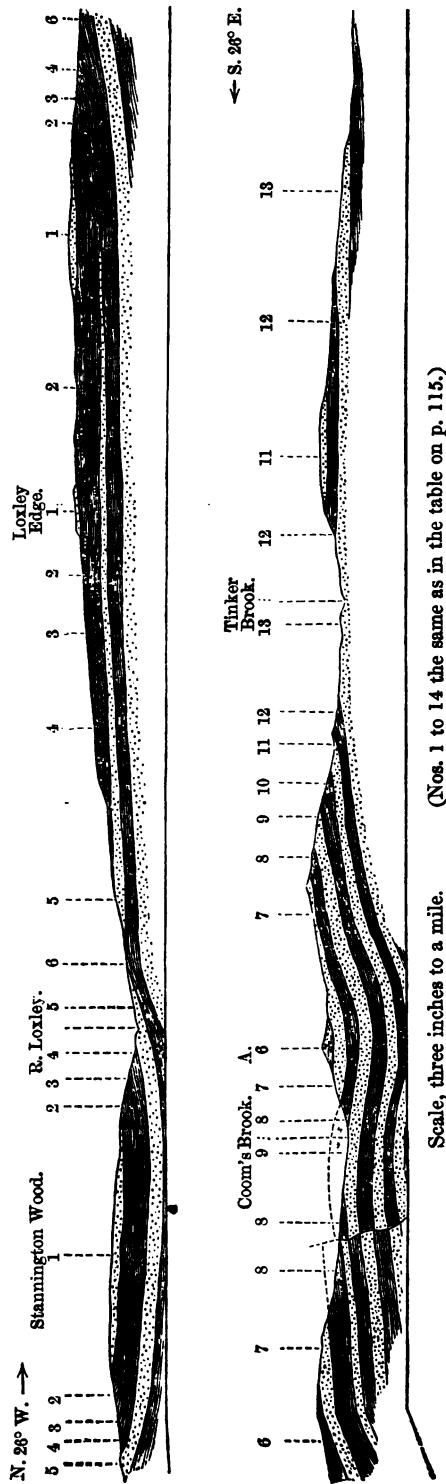
The country which we will take in hand first reaches from the valley of the Ewden Beck* on the north to the north Rivelin fault (p. 72) on the south. Its boundary on the west is a broken line formed by the Onesmoor (p. 56), Bradfield (p. 57), Agden (p. 56), and Dungworth (p. 59) faults, and on the east it reaches up to the valley of the Don, along which runs a line of fault, the Don Valley fault, which we will here describe.

That some very marked line of fault ranges along the valley is very clearly seen when we compare the country on the west side with that on the east in the neighbourhood of Oughtibridge. On the one side we have the beds from 7 to 13 lying below the Ganister Coal, with a general east and west strike; while in the opposite bank we find the outcrop of the Ganister Coal itself, ranging nearly north and south. The position of the fault can only be fixed within certain limits, but at some spots we get evidence enough to make these limits very narrow indeed. Thus at Bithomles House, a mile and a half north of Oughtibridge, we have on the west bank the sandstone No. 13, capping a steep cliff formed of the underlying shales, and the dip is a little west of south. The base of the sandstone can be distinctly traced down to the river, and if the measures were unbroken we should find it again on the opposite side, rising from the stream and forming a ridge with an easterly range corresponding to that made by it on the western side of the valley. About 300 yards lower down the stream, however, there is a section showing a sandstone bed, dipping E.S.E., or in a direction nearly at right angles to the dip of the bed on the western bank, and this sandstone is found to be No. 9, or the third sandstone below the Ganister Coal. Between these two sections the fault must run, and they are so close together that the possible amount of error is here very small indeed. By observations like this the position of the line has been fixed with more or less certainty, and it seems to range a little east of south as far as Usher Wood. Here the line makes a very sudden bend to the east, following in so noticeable a way the course of the valley, that one can hardly help thinking that the connexion between the two is more than accidental, and that the fracture has given rise to a line of weakness along which the stream first began to excavate its channel. Hence southwards we still find the fault sticking in a marked way to the course of the valley, its direction being very nearly south-east.

The section, Fig. 34, is drawn from north to south across the country we have now to describe.

* In Map 87 S.W.

Fig. 34.
Section from North to South across the Lower Coal Measures of Oughtibridge, Loxley, and Stannington.



Starting with the lowest beds, the shales No. 14, we may notice the somewhat unusual occurrence in them of veins of galena. Two of these lodes have been worked near Moor Hall Bridge, but the mines have been long since abandoned, and beyond the traces still to be seen on the ground we could learn nothing of them. A good deal of galena is still lying about mixed with a hard, closely grained sandstone, stained by manganese (?), which seems to have formed the vein stone. Lead is also said to have been worked two miles higher up the Ewden valley near Broomhead Mill.

The base of the sandstone No. 13 is often a bed of massive, coarse gritstone, which is well seen in the turnpike road below Bitholmes House, and again in Tinker Brook about 300 yards east of the farmhouse Bent Hill Holme, the section there being—

		Approximate thicknesses.	
		ft.	in.
13	Flaggy sandstone	-	-
	Coarse massive grit	-	20 0
	Dark shale	-	1 0
	Hard sandy shale	-	5 0
14	Hard flaggy sandstone	-	5 0
	Dark shale	-	1 0
	Hard flaggy sandstone	-	3 0
	Hard sandy shale and tilestone	-	10 0
	Dark shale	-	-

In the brook running northwards from New Thorn House we again get a section showing the base of a bed which there is every reason to believe is the same sandstone, and there we find no trace whatever of the above-mentioned coarse grit, the rock being a finely grained, flaggy sandstone. This is one of the many instances we shall have to notice of rapid changes in the mineral character of these Lower Coal-measure Sandstones.

In a quarry 100 yards west of New Thorn House we have the following section in beds which must lie close on the top of No. 13:

		ft.	in.
Sandy shale with a little flaggy sandstone	-	-	-
Hard closely grained sandstone, rather thickly bedded	-	8	0
Ganister and ganisterlike rock	-	4	0
Coal about 1 foot seen.			

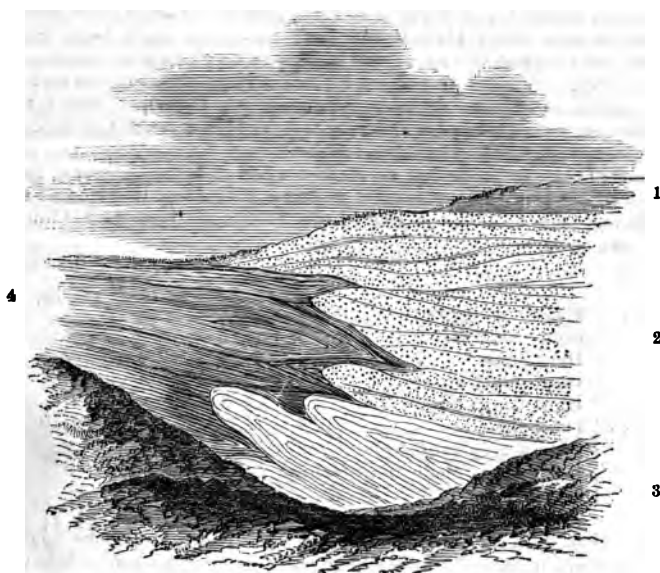
No other sections were seen showing the junction of No. 13 with the overlying shales, so that we cannot say whether the coal is persistent or not.

An outlier of sandstone No. 11 lies on the hill top near Swinnock, and a strip of it crops out on the south side of the valley of Tinker Brook, ranging from the Onesmoor up to the Don Valley fault through Dob Carr. There were scarcely any sections.

The ridge formed by the outcrop of No. 9 sandstone abuts against the Onesmoor fault on Bent Hill a little lower down the slope than the escarpment of the Rough Rock on the west of the fault; this it will be recollected was one of the best fixed points of this line of fault (see p. 58). The rock is here a flaggy sandstone, it is well shown in a plantation north of Hill House, and again is largely quarried on Delf Hill. Hence the bed ranges through Usher Wood, where it is well shown in a magnificent cliff; a long tongue of it runs up the valley of the Coumes Brook, and the outcrop winding round below Hagg Stones abuts against the Don Valley fault opposite Beeley Wood Forge. For the latter part of its course the sandstone becomes so split up with shale as to make the tracing of it a matter of great difficulty. The section given in fig. 35 shows a remarkable case of the interlacing of shales and sandstones in this bed, which we were lucky enough to find laid open by the roadside between Oughtibridge and Wadsley Bridge, 100 yards north-west of a public-house called the Corporation Arms.

On the south side of the Coumes valley at Oughtibridge a bed of sandstone, ranging through the church, crops out below No. 9, which therefore belongs most likely to No. 11. There were no traces of a corresponding outcrop on the north side of the brook, and a fault has therefore been drawn a little way up the valley cutting off the bed on the north.

Fig. 35.



1. Hard sandy shale.
 2. Sandstone mixed with and passing into sandy shale.
 3. Sandy shale ending in concretions to the left hand.
 4. Dark shale with thin layers of coal, dovetailing into the beds on the right hand.
- Height of section six feet.

A fireclay lying on the top of No. 9 has been worked in Cockshutts Lane, Oughtibridge. The following section was given us:—

	ft.	in.
Clean, evenly bedded black shale	-	-
Measures said to be all shale	-	-
Soft crumbly black shale, crowded with <i>Goniatites</i> and <i>Aviculopecten</i>	45	6
Hard black shale approaching a cannel coal: <i>Anthracosia</i> , <i>Cypripis</i>	-	-
Pot clay	7	0 to 8 ft.
Sandstone No. 9.		

The sandstone No. 7 shows changes in mineral character as remarkable perhaps as any in the group now before us. It forms a capping to the hil on which the hamlet of Onesacre stands and covers the eastern part of Onesmoor, being thrown by the Onesmoor fault against the Crawshaw sandstone which overspreads the western part of the moor. Over all this country the bed shows as a finely grained flaggy sandstone, and quarries and sections are plentiful as far as Burnt Hill: tracing the rock hence eastward, though the ridge formed by its outcrop is sharp and unbroken, we nowhere see the stone itself till the large quarries above Hagg Stones. In this short distance, however, of less than half a mile it has undergone a most marked change, having put on the form of a gritstone, coarse and very thickly bedded, a rock indeed as striking as any of the millstones themselves. In its further course to the east the bed apparently thins out very much, its under line south of Middlewood Hall until it abuts against the Wadsley fault* being somewhat obscure. This rock was reached in a bore hole rather more than a quarter of a mile south-east of the Yews, the section of which, given below, shows that the fireclay and ganister which not unfrequently lie on the top of No. 7 sandstone are wanting

* We give this name to a fault ranging east of south through Wadsley Church.

hereabouts; however, a little to the south-west of Onesacre there is an outlier of the overlying shales shown on the section, fig. 34, at A, and a coal about 10 inches thick with an underclay was seen at the junction. There were no other sections along the upper boundary of this bed, so that we can say nothing for certain about the range of this coal, or of the fireclay of which it seems to be the equivalent, but it might be worth while to make a few trial holes along the upper boundary, especially as the clay is worked on the opposite side of the Don valley, as we shall see when we come to the account of that country.

The sandstone No. 5 may be seen at Worrall where a fireclay has been worked on the top of it; westwards from the village it seems to thin away, but it may be traced to the south-east till it abuts against the Wadsley fault.

The following is the section* of a bore hole rather more than a quarter of a mile south-east of the Yews, made nearly upon the outcrop of the thin coal and fireclay overlying No. 5.

		ft.	in.	ft.	in.
	Sandstone and boulders	-	-	8	0
	Coal	-	-	0	8
	Fireclay	-	-	2	0
No. 5	Strong freestone	-	-	43	6
	Stone and shale	-	-	12	2
	Greystone	-	-	4	8
	Greystone and shale	-	-	23	6
	Dark grey shale	-	-	27	10
No. 6	Strong stone	-	-	15	4
	Black shale	-	-	10	4
	Grey shale	-	-	8	8
	Black shale	-	-	9	9
No. 7	Whitish gritty stone	-	-	14	8
	Strong gritty stone	-	-	9	1
				196	2

The coal, a foot thick, and the fireclay are seen in the stream some hundred yards to the west of the Wadsley fault.

We will now come to the outcrop of the Ganister Coal and the outliers of the sandstone No. 1 found above it. Starting at the Wadsley fault, the crop may be traced either by the old or present workings to the north-west as far as the farmhouse Spite Winter.

In Bull Piece the following section was seen:

		ft.	in.	ft.	in.
Seen	Dark-grey shale	-	-	-	-
	Black shale more finely bedded than the shale above	-	-	2	0
	Coal	-	-	1	6 to 2
	Ganister, very hard	-	-	2	6
Workman's account	Hard white sandy clay	-	-	0	4
	Bastard ganister.	-	-	-	-

A very similar section was seen east of Stubbing, but here the top inch or two of the coal was beautifully bright and clear. I was told that the following beds had been proved below the coal:

		ft.	in.
No. 3.	Ganister	-	2
	Bastard ganister	-	3
	Sandstone (A)	-	4
No. 4.	Bind	-	36
	Fireclay.	-	0
No. 5.	Sandstone.	-	-

To the west of Spite Winter the sandstone marked (A) in the last section seems to thicken out, and compensates for the absence of No. 5, which, as we have already mentioned, thins away westwards from Worrall.

* Furnished by Mr. Skelton.

The distance between the coal and the overlying sandstone No. 1 is hereabouts only from 10 to 15 yards.

A little to the south of Spite Winter the coal is thrown down to the south by a fault. This is clearly shown by the fact that the crop of the coal along Myers Lane lies at least 40 yards below the base of sandstone No. 1, whereas the two are really only 10 or 15 yards apart, and also by the presence of a small patch of the rock No. 1 itself below the escarpment of the main mass. A prolongation of the Bradfield fault (p. 57) explains very well the observed facts.

To the south of this fault the crop of the coal ranges along Myers Lane, and below Loxley Edge, till it reaches the river Loxley. An open work south-west of Wadsley Church gave the following section :

						ft.	in.
Grey shale	-	-	-	-	-	15	0 seen.
Coal	-	-	-	-	-	1	10
Ganister	-	-	-	-	-	2	9

After crossing the river Loxley the outcrop winds round, forming nearly a complete oval, and runs down to the river again a little above Malin Bridge (the junction of the Loxley and Rivelin brooks), and is soon after cut off by the fault which ranges down the Rivelin Brook.

The following are the measures passed through in two pits sunk to the coal in Stannington Wood :

		ft.	in.	ft.	in.	ft.	in.
1.	Sandstone No. 1	-	30	0			
2.	{ Bind	-	39	0		39	0
	{ Grey stone	-	9	0		12	0
	{ Bind	-	42	0		39	0
3.	{ Coal	-	1	8 to 1	9	2	0
	{ Ganister	-	1	0 to 3	0	0	6 to 5 0

Here the measures No. 2 which beneath Loxley Edge were only from 10 to 15 yards thick have swelled out to 30 or 40 yards.

In an open work about 30 chains S.S.W. from Malin Bridge the following beds were shown :

						ft.	in.
2.	Dark shale.						
3.	{ Coal smut	-	-	-	-	1	3
	{ Ganister	-	-	-	-	3	0
(4.)	{ Bastard ganister	-	-	-	-	4	0
	{ Hard, closely grained sandstone, proved to a depth of					16	0

The sandstone here lying immediately below the Ganister Coal would seem to be one of the beds of bastard ganister and sandstone which the colliers tell us are found here and there among the beds No. 4 of the general section on p. 115.

Between this spot and Stannington the details are very obscure. A sandstone, agreeing pretty fairly with No. 5, can be traced from Stannington Church through the upper part of Roscoe Plantation down towards the River Rivelin, but its boundaries are far from clear. There were no sections to show whether the overlying coal and fireclay are present. Between the "h" and "k" of the words "Haugh Park," on the one-inch map, a well was sunk through twenty feet of shale down to a ganister and fireclay, one foot six inches thick, resting on a bed of sandstone. The latter is most likely the sandstone No. 7, and the beds above No. 6.

We may now say a word about the outliers of the sandstone No. 1, which lie within the crop of the Ganister Coal just marked out.

About Low Ash the bed is a very coarse, massive grit, and has been largely quarried. On Loxley Edge it has the same character and is very regularly jointed. The southerly escarpment of this little ridge is very remarkable. For a distance of about 10 chains from the edge the ground below is so thickly covered with large loose angular blocks of the rock that a person might step, not jump, from block to block for more than half a mile without touching the ground. On looking at this ruined mass, it at once strikes us that the escarpment must formerly have reached farther to the south, that the weathering of the under-

lying shale has caused the rock, which dips to the south, to keep tumbling over on that side, and that this mass of loose stones is the ruin of the escarpment so destroyed; climbing the cliff we find our impression confirmed; all along the escarpment the hill is like an ill-laid pavement, the joints yawning, and everything looking so loose and unsettled that we instinctively keep away from the edge, lest the mass we are standing on should topple over and hurl us down on to the stony ground below. And we may notice all stages of the process. Here a joint has just begun to open, another mass has already slipped a little and begun to turn on its lower edge, while a third has so far tilted over that before long it must join the heap below. The rock soon loses its coarse character, and about Stannington Wood is an ordinary sandstone.

The most notable feature in this No. 1 sandstone is its habit of becoming in places an excessively coarse massive gritstone, and it is interesting to notice that a rock holding exactly the same position in the Lancashire Coal-field behaves very often in the same way. The bed has been named by Mr. Hull "The Helpet Edge Rock," and he says of it that "in one quarry it was so like Rough Rock, that it was only the fact of its overlying the Ganister Coal that prevented it from being mistaken for that formation." (Memoirs of Geological Survey; Geology of the country round Oldham, p. 17.)

To the south-west of the outcrop of the Ganister Coal, the sandstones Nos. 5, 7, and 9, crop out on each flank of the Loxley valley, abutting on the north side against the Agden fault, which ranges across by Storrs Bridge Forge, and being cut off on the south side by a fault ranging nearly north and south through Stannington. This latter fault was seen just above Rowel Bridge, and cuts off the escarpment of No. 5 in a very marked way to the south of Spout House: its course southwards from Stannington is doubtful. Of the sandstones themselves but little can be said. On the north side of the valley they form but ill-marked features; No. 5 ranging as far as could be ascertained through Hollin and Loxley Houses, Wisewood, and so down to the Loxley river; while No. 7 runs by Lee Bank, behind Loxley Chapel, and through Loxley. On the south side of the valley No. 5 forms a very good escarpment, best seen in the picturesque cliffs of Little Matlock: its thickness is about 50 feet, and owing to the steep slope of the ground its outcrop for some distance forms only a very narrow strip. A short way over it there are some beds of ganister which form a well-marked but slight feature in the ground. No. 7 also forms a pretty good feature on this side the river, though its thickness must be but slight; while No. 9 appears in and around the bed of the river east of Rowel Bridge.

There now remains to be described a wedge-shaped bit of ground lying between the Dungworth and Agden faults.

Starting with the highest beds, we have an outlier of the sandstone No. 1 and the Ganister Coal, abutting against the first of these faults to the south of Dungworth.

The following are sections of two of the pits:

		ft.	in.			ft.	in.
No. 1.	Soil and rubble	7	6	Rock	-	-	42 0
	Rock	-	9 0				
No. 2.	Shale	-	41 0	Dark shale with thin			
	Bind, hard	-	48 0	bands of stone	-	84	0
No. 3.	Coal	-	2 3	Coal	-	-	2 3
	Ganister	-	0 6	Ganister.			
	White clay	-	6 0				

The Ganister Coal of this outlier is now very nearly worked out. The measures No. 4 are said to be about 24 yards thick, and the coal at the bottom of them from 10 to 15 inches.

Sandstone No. 5 makes throughout a very fine escarpment. A very admirable section, showing its base, is given by the lower part of Load Brook, in Bent's Wood, where the word Syke is written on the 1-inch map: * a sharp anticlinal runs along the stream, bending up the underlying shales, while on either side overhanging cliffs of the sandstone cap the steep sides of the dell.

* See 6-inch Map of Yorkshire, No. 294.

The fireclays lying on sandstones 7 and 9 are both largely worked in this neighbourhood.

West of Underbank a section in the former showed

No. 6.	Black shale (<i>Goniatites</i> , <i>Aviculopecten</i> , <i>Posidonia</i>).				ft.	in.	ft.	in.
	Coal in some places	-	-	-	-	0	0½	
	Ganister	-	-	-	-	0	3 to 0	4
	Fireclay	-	-	-	-	2	6 to 5	0
No. 7.	Sandstone	-	-	-	-	—	—	

The clay is very sandy, some way from the outcrop almost a sandstone; it is used for fire-bricks; some of the harder part is ground down separately, allowed to stand on a floor, and then reground very fine and sent to Sheffield, where it is used to stop up cracks in the furnaces.

The same clay is worked above Beacon Wood, where we found the following section :

No. 6.	Black shale.				ft.	in.	ft.	in.
	Coal	-	-	-	-	0	0½ to 0	0½
	Fireclay	-	-	-	-	2	0	
	Do. whitish, rather sandy	-	-	-	-	2	0	
	Yellow and red clay	-	-	-	-	0	6	
	Clay	-	-	-	-	0	6	
No. 7.	Sandstone.							

The following section was seen in the fireclay resting on sandstone No. 9, a little south-east of Beacon Wood :

Black shale.				ft.	in.	ft.	in.
Coal	-	-	-	-	0	0½ to 0	0½
Ganister	-	-	-	-	1	0 to 1	6
Sandy fireclay	-	-	-	-	4	0	

Further to the north-west the same clay is worked, and a tramway running down the slope of the hill shows well both clays and the intermediate measures. In the lower part of the cuttings the beds rear up at an angle of 80° tilted by the Agden fault, which seems to run just down to this spot and there die out.

In the north-western part of the wedge of country we are now describing a well-marked bank of the sandstone No. 5, cut off to the north-east by the Agden fault, lies on the east side of the valley, and the overlying coal was seen in a road cutting north-east of Stacey Wheel. Over the rest of the ground we have not been able to trace out the sandstones with any accuracy, owing no doubt partly to the contorted and broken state of the beds. The sections in the Bradfield Brook show great disturbance, and when we consider that the rocks are here jammed closely in between two large faults this is only what we must expect.

As we have in this district reached the point at which the Agden fault dies out to the south, we will collect shortly the evidence for this long line fracture.

In the fireclay workings on the south-west of the Loxley valley, described a little way back, the beds between No. 7 and No. 9 sandstones are tilted up at a high angle; the spot where this occurs lies pretty nearly where we should expect the fault to run, and therefore we conclude that the disturbance reaches so far south; beyond this, however, the fault certainly dies out, for the outcrops of sandstones and fireclays can be traced round the hill into Storr Brook without the slightest sign of a break. Evidence is next found to the north-west in the presence of an outlying strip of No. 5 sandstone, clinging as it were to the fault, on the north-eastern side of the Bradfield valley; this is cut off in a very marked way east of Stacey Wheel, and brought against the escarpment of the Rough Rock south-east of Peck Hall; while *immediately above* it is the escarp-

ment of the Crawshaw sandstone on Holdworth Bank, the intervening measures some 600 feet at least in thickness being altogether absent; all these difficulties are cleared up by the fault as drawn on the map. Again the fault cuts off the Third Grit, and was seen in a brook, 10 chains south-west of Bradfield Church; and a little further to the north-west at Smallfield brings the Upper Kinder against the Second Grit (p. 58). The striking difference between the trend of the rocks on opposite sides of the Agden valley, which first led us to infer the presence of this fault, and the sections which enabled us to fix its place thereabouts, have been described on p. 56. Further north the fault is well seen in the ridge of Herculean Stones, north of Flint Hills, and in the Ewden Brook, but the details must be kept for a future memoir, as these spots lie beyond the boundaries of the country now under consideration.

Lower Coal Measures about Ecclesall.

We give here a few stray notes on this district.
The general section is as follows:

	ft.	in.	ft.	in.
1. Brincliffe Edge rock - - -	-	-	150	
2. Shales - - -	-	-	150	
3. Sandstone - - -	-	-	50	
4. Shales - - -	-	-	100	
5. Sandstone - - -	-	-	50	
6. Shales with a thin bed of sandstone -	-	-	130	
7. { Ganister coal - - -	-	-	0	3 to 2 3
{ Ganister and underclay.	-	-		
8. Measures - - -	-	-	60	
9. Rattlers or Cannel coal.				
10. Sandstone.				

No. 1 is a closely grained thickly bedded sandstone, largely quarried on Brincliffe Edge.

The sandstone No. 3 seems very changeable in thickness, it is generally flaggy and not of much value.

The bed No. 5, the sandstone immediately above the Ganister coal, keeps the same changeable character as it had about Loxley and Stannington. In the road cutting above Ecclesall Church it is a flaggy rock with interbedded sandy shales, while in the quarries above Greystones it is thickly bedded and very closely grained, yielding excellent paving blocks; some parts of it here are also very coarse.

The measures between this sandstone and the Ganister coal, though they have exactly the same character as at Stannington, namely shales with a thin bed of sandstone, are here slightly thicker.

The following is a section of a pit sunk to the coal nearly opposite Ecclesall Church:

	ft.	in.
4. { Shale - - - -	-	36 0
{ Hard white clay, weathering soft	-	2 3
5. White rock - - -	-	51 0
6. { Shale - - - -	-	15 0
{ Grey stone - - - -	-	9 6
{ Shale - - - -	-	100 0
7. { Coal - - - -	-	2 3
{ Underclay (no ganister here).		

About 20 chains south-west of Greystones the crop of the coal was seen in an open work, which gave the following section:

	ft.	in.
Black shale.		
Coal - - - -	-	2 6
Ganister - - - -	-	2 0

The crop was again seen in a cutting in Smiths Wood, and there we had

6.	Black shale.	ft.	in.
7.	{ Coal - - - - -	0	3
	{ Ganister - - - - -	1	3
	{ White sandy clay with lumps of sand- stone - - - - - }	3	6
8.	{ Light buff shale.		
	{ Black shale.		
	{ Sandstone.		

From these sections it appears that both Coal and Ganister are hereabouts very changeable.

In the Porter Brook, immediately below this last section, we see the beds below the Ganister Coal; the section showed

7.	Ganister.	ft.	in.
	{ Gap - - - - -	about	20 0
	{ Sandstone - - - - -		
8.	{ Black shale and ironstone - - - - -	about	40 0
	{ Hard blue sandstone - - - - -		
	{ Black shale - - - - - }		
9.	Rattlers or Cannel coal.		

The bottom bed is a hard, carbonaceous, black shale, well jointed, and breaking up into rectangular parallelepipeds, which rattle about against one another when the coal is shovelled out, whence the name. We are inclined to think that this bed represents either one of the beds of bastard ganister in No. 4, or the coal at the bottom of No. 4, in the Stannington and Loxley section, on p. 115.

The beds from No. 5 downwards are repeated on the west by a fault ranging nearly north and south through Broad Oak Green. There are no workings now going on to the downthrow side of this fault, and the crop of the Ganister coal can only be laid down approximately. A lower bed of Ganister was seen in the Porter Brook, four-tenths of a mile below Whitely Wood Works. The section was as follows :

	ft.	in.
Black shale (<i>Aviculopecten</i> , <i>Goniatites</i>).		
Hard ganister - - - - -	1	6
Hard sandy underclay mixed with ganister - - - - -	1	9
Flagstone.		
Dark shale.		
Flaggy sandstone.		

This Ganister seems to be about 170 feet below the Ganister coal and cannot therefore represent the "Rattlers;" perhaps it is the equivalent of the fireclay and ganister No. 6, or the coal on the top of No. 5, in the Stannington section (p. 115).

We add the following sections of the Ganister coal in Abbey Dale, where it has been largely worked for the sake of the underlying fireclay and ganister.

Section in Ecclesall Wood.

	ft.	in.
Hard black shale with ironstone.		
Soft grey shale - - - - -	2	0
Dark grey shale - - - - -	1	0
Very finely laminated black shale - - - - -	0	5
Coal - - - - -	0	4
Ganister - - - - -	2	0
Fireclay.		

which it has been drawn up are of very unequal authority, these shall first be laid before the reader. In the quarter sheets, 88 S.W., and 81 N.W., the Drift has been mapped by my colleague Mr. Hull, who has kindly sent me a reduced copy of his maps; in 81 S.W. the Drift has also been mapped by the Geological Survey. In 72 N.W. information has been given by Mr. J. Ward of Longton, but the boundary is for the most part conjectural. In 88 S.E., 81 N.E., and 81 S.E., the observations of the Geological Survey have pretty fully proved the absence of Drift, with the exception of the few patches marked; other small detached masses like these may have been overlooked, but this is neither very likely nor very important. In 72 N.E. we have been able to draw an approximate line to the north of which Drift is not found; to the south of this line, though Drift is found in large quantities, the country is not everywhere covered by it; in absence of detailed information the map may be taken as exact enough for our present purpose. Towards the south-west corner of the quarter sheet, however, the line is very doubtful. In 87 S.W. the country has been sufficiently examined by the Geological Survey to make the map trustworthy; the same may in some measure be said of 82 N.W., 82 S.W., and the northern part of 71 N.W.; in the southern part of the latter we are still very much in the dark. In 87 S.E., 82 N.E., and to a smaller degree in 82 S.E., and 71 N.E., the observations of our colleague Mr. Aveline have enabled us to lay down a drift boundary most likely not far from the truth. Generally, however, the shaded part of the map must be taken to show the area within which Drift occurs, but it must not be supposed that the whole of it is covered with Drift.

Heights have been taken where possible from the maps or levellings of the Ordnance Survey; failing these, from the Horizontal Sections of the Geological Survey, from personal measurements, and other sources; they do not claim to be minutely accurate, but are near enough for our purpose.

Let us first glance at the shape of the country. In the middle is the tract of high ground forming the southern end of the Penine chain. The outline of this is marked on the map by a strong stroke-and-dot line. Though channelled in every direction by deep valleys, this ground may be looked upon as a table land, bulging up in the centre; its margin has an average elevation of about 1,000 feet above the sea, and the highest points on it fall little short of 2,000. This raised tract is bounded on the west, south, and east by a plain whose average height above the sea is not more than 400 feet. The western descent from the hill country to the plain is steep, because the hard rocks which form the former pass with a high dip below the softer rocks of the latter, or are brought against them by faults. On the east the slope is much more gradual, because the rocks of the high land pass beneath those of the plain with a small dip. On the south the angle of the slope varies with the dip or the nature of the boundary.

The distribution of the Drift over this country is in general terms as follows. On the west the plain is everywhere thickly covered with it, it runs up the slopes of the central tableland, and patches of it and erratics are found on the tableland itself, *along its western margin*, up to a height of 1,200 feet above the sea. The distribution on the south is very nearly the same as along the west side, but the plain is not so completely covered, and the greatest height reached is rather less. With the exception of the patches on its western margin just mentioned, the central plateau is perfectly free from Drift; but in the one case of a valley which cuts well across it, that of the R. Wye, there is reason to think that the Drift has found its way through the gap, at all events

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Drift is found along the valley. Passing to the eastern side of the range, we find a vastly different state of affairs; for a distance of from 10 to 20 miles from the eastern edge of the central tableland the plain is, with the exception of a very few erratics and little patches of Boulder Clay, altogether free from Drift; and when beyond this we do reach a country where Drift comes on, we find it thin, and instead of wrapping the whole land in one widespread covering occurring only in scattered patches. It seems too that the Drift on this side contains fewer foreigners and is more largely made up of local rocks than on the west.

Having now stated the general facts, we may pass to details and an explanation of the map.

Drift on the West and South of the Penine Chain.—In quarter sheets 88 S.W., 81 N.W., and 81 S.W., we have nothing to add to the account of the Drift already given in the published Survey Memoirs.* In the last, however, it is curious to notice how the Drift has found its way through several gaps in the great barrier of the Penine chain, and spread out long arms to the west and south; how far these arms run on into 72 N.W. we do not exactly know.

In 72 N.W., 73 N.E., and 72 S.W., with the exception of information about the neighbourhood of Stoke, kindly given by Mr. J. Ward of Longton, we have little to offer. Drift is found thereabouts in the valley of the Trent, but in several places where it has been worked it was only six feet thick. Drift is found in force in the northern part of 72 S.W., and though our lines are no better than rough approximations, there seems every reason to believe that it sweeps round to the east in the way shown on the map.

In 72 N.E. we have first to notice two outlying patches on the central tableland, some way north of the main mass of the Drift. One runs for about a mile and a half to the south of Butterton, and reaches a height of 1,150 feet. The other begins at Hope Marsh and stretches thence about a mile to the north; it ranges in height from 800 to 900 feet above the sea. They consist of clay, with pebbles of quartz rock and other foreigners. Of the mass of Drift which covers the greater part of this quarter-sheet south of the Mountain Limestone Boundary we know as yet but little. It is for the most part clayey, and contains ice-scratched angular blocks of Mountain Limestone in plenty; gritstone; quartz pebbles, and sand from the Bunter Beds; igneous rocks; and, it is said, chalk-flints, though it is just possible that what has been taken for the last may be Mountain Limestone chert. For the most part it keeps clear of the Mountain Limestone, but about Tissington hides the boundary of that formation, and in the north-east corner of the map a thin sprinkling of clay, sand, and quartz pebbles covers the limestone in places at a height of 1,100 feet above the sea. There is also a patch of what is most likely Drift one mile S.W. of Wirksworth Church, at the "k" of the words "Petty Sprink." It consists of sand and pebbles of quartz rock, seemingly the ruins of Bunter Conglomerate, and half-rounded blocks of limestone, and lies in a chasm in the limestone, with vertical sides, 51 yards wide, and ranging W. 10° N. A very similar deposit was seen at the foot of Hopton Moor Inclined Plane, two miles north-west of Wirksworth.

A large patch of Drift Gravel lies on the hill-top one mile south-west of Kirk Ireton. It is nothing but rearranged Bunter Pebble-beds, and has so thoroughly the characteristic outline of the hills formed by those conglomerates, that for a long time it was taken to be an outlier of that rock. Some large pits, however, north of Blackwall, showed unmistakeably its true character; the look which the beds have in section can hardly be described in words, but its distinctive stamp is clearly and immediately perceptible to a trained eye.

The Drift runs on into the adjoining quarter sheet 71 N.W. up to a spur of the central tableland formed by the outcrop of the Kinder Scout Grit, and ranging from Barret Edge, by Allport Heights (1,026 feet above the sea) to Little Eaton. This seems to have formed a barrier to its further progress to the east, but at the south end of the line of hills, where the elevation becomes

* The Geology of the Country round Oldham, p. 46; and the Geology of the Country round Stockport, Macclesfield, Congleton, and Leek, p. 74.

smaller, the Drift has found its way across and spread itself over the plain to the east.

Drift in the Valleys of the Wye and Derwent.—Beside the railway, just south of the group of houses called Monsal Dale on the map, the cutting runs through a large bank of limestones, "scree," or "slithes," as they are sometimes called in Derbyshire. These "scree" consist mainly of angular fragments of limestone, which have weathered off from the rock on the hill tops and slid down into the valley, but here in the middle of the debris is some gravel mainly made up of small limestone pebbles, but containing besides ice-scratched boulders of limestone, large pebbles of gritstone, and one pebble of red granite. A little further on was some stiff dirty clay, full of stones, lying on the limestone, and running down into the fissures. Till the railway cutting removed the overlying debris this little patch of Drift must have been entirely hidden. The ground is about 600 feet above the sea.

Again, a little further to the east, in the railway cuttings between Longstone Station and Rowdale House, we find patches of a deposit which, though possibly an old river gravel, is most likely Drift, covering the ground lightly or lying in hollows in the stratified rocks. It consists of coarse and fine limestone gravel, with lenticular beds of sand, and contains many angular and half-rounded blocks of limestone covered with ice-scratches. It lies 600 feet above the sea, and about 100 above the present level of the Wye.

On the hill top at Toast Wood, one mile west of Baslow, the soil is clayey with rounded masses of limestone and toadstone. We cannot say for certain that this is Drift, but it looks very like it. Though not strictly within the present valley of the Wye, this spot is not barred off from it by ground of any height, and we therefore place this doubtful case among the Wye Valley patches.

The ground to the south-west of Bakewell, between the town and Moor Edge Plantation, is covered by a dirty clayey soil, most likely Drift.

Lower down the valley the flat-topped hill to the east of Haddon Hall, from Park Bank Plantation on the north to Parkside Wood on the south, is covered by a stiff red clay, not unlike the clay found in the limestone caverns, containing many boulders of limestone, angular or half-rounded, and thickly covered with ice-scratches; and in smaller quantity toadstone, gritstone, greenstone different from toadstone, and granite (one specimen seen, coarse and grey). Over the greater part of the hill the limestone boulders are so thickly strewn that one would imagine the rock itself was just below, and the walls are all built of limestone. There can be no doubt of this being genuine Boulder Drift, but fringing the east side of the valley, at a height of from 20 to 50 feet above the river, is a band of finer gravel, consisting mainly of limestone pebbles, which looks more like a river-gravel, perhaps derived from the Drift, but remodelled by the stream. This gravel was well shown in a road cutting at the west end of Haddon Tunnel, and in the railway at the west end of Parkside Wood. The drift-covered ground is probably between 500 and 600 feet above the sea.

Drift was also seen in the tributary valleys of the river Dakin or its feeders; clay with ice-scratched blocks of limestone at the west end of Car Plantation north-west of Stanton, and about Round Knowl west of Stanton; at Greenfield, one mile south-east of Yougholgreave, clay with quartz pebbles; and by Bury Cliff, three-quarters of a mile north-west of Elton, clay with a few limestone pebbles.

Traces of what is probably Drift were seen below Peak Tor south of Rowsley, where the soil contained a few pebbles of limestone and chert.

Between Cromford and Bonsall is a rock called the Bloody Stone, which is polished and scratched, possibly by ice. It was noticed by Mr. Mackintosh (Geological Magazine, Vol. II., p. 380), and described by one of the authors of the present memoir (ibid. p. 440). Professor Ramsay has since visited the spot. He declined to give a positive opinion, saying that if in a well glaciated country it would pass muster as a truly ice-scratched rock; but that, lying as it does, the only known evidence for land glaciation, it was not satisfactory enough to be accepted as conclusive proof.

The dip-slope of Riber Hill, south-east of Matlock, is thickly covered with Boulder Clay. Glaciated blocks and pebbles of Mountain Limestone, pieces of chert, and one smoothed and scratched bit of sandstone were seen. The

ground lies some 300 or 400 feet above the bottom of the Derwent valley, but is connected with it by a valley running from Nether Tansley towards Matlock.

The country east of Holloway is covered with stiff clay containing many large quartz pebbles.

The southern end of the Crich Limestone is covered with Boulder Clay. This ground lies at the head of a broad valley which opens into the valley of the Amber, and is so connected with that of the Derwent.

Lastly, over the dip-slope of the Kinder Scout Grit between Alderwasley and Belper, that is, on the western flank of the Derwent valley, we find patches of Boulder Clay and gravel up to a considerable height above the river. These may form a part of the Drift that has found its way along the Wye and Derwent gap, or they may be stray patches which have come over the ridge of Alport Heights, which seems to have formed a barrier to the progress of the main mass of the Drift in its progress eastwards.

It now remains to explain the presence of these patches in a country elsewhere altogether free from Drift. First we notice that they are all found in the valley of the Wye and that part of the valley of the Derwent which lies *below* the junction of the two rivers; the valley of the Derwent *above* its junction with the Wye being clear of Drift, and this at once leads us to suspect that they have come from the west through a gap cutting across the great barrier of the Penine chain. Such a gap can be shown to exist. The valley of the Wye will serve as far as Buxton, where the height of the river is about 1,000 feet above the sea; thence the line of the London and North-western Railway to Stockport runs along a valley whose summit level at Doveholes is not more than 100 feet higher, and descends into the valley of the Goyt at Whaley Bridge, where the ground is less than 700 feet above the sea; the valley of the Goyt will serve for the rest of the way. The brooks marked on the map show the line of the gap. Here then is a pass over the hill country whose summit is not more than 1,100 feet above the sea; and, since the depression of the land must have been more than 1,200 feet, this would in glacial times have been a strait, open to the passage of floating ice and sediment. We certainly do not find Drift all along this line, and unluckily nowhere at the summit of the pass, where the water would be shallowest, and the chances of an iceberg's stranding greatest; but we do not know how much has been carried away by later denudation, and as the land rose there would probably be a strong current through this strait till the summit of the present pass was above water. The scour of this might remove all traces of Drift above that level, and only those patches which lay lower would remain to tell the tale of what had been.

The above explanation will be more satisfactory if we can show that Drift has in like manner found its way through other gaps in the Penine chain. Luckily we can put in evidence two such cases. The valley of the Calder cuts right across the ridge; as far as we know, no drift is found in it at the summit level; but at Hebden Bridge* and at Elland† boulders of granite and other foreigners are found in it, at the latter place in fair plenty. The valley of the Aire also, near Bradford, is full of drift,† which seems to have found its way from the west. Another case is the well-known pass of Stainmoor, in the escarpment of the Mountain Limestone of the northern part of the Penine chain, over which the granite of Shap Fell has travelled. Professor Phillips

* Observations on the occurrence of boulders of granite and other crystalline rocks in the valley of the Calder near Halifax. J. T. Clay. Transactions of the Geological and Polytechnic Society of the West Riding of Yorkshire, vol. i., June 3rd, 1841, p. 201.

† As we learn from our colleague, Mr. J. C. Ward.

states* that here, and here only, have "blocks from the western hills crossed that immense barrier." He also mentions that Stainmoor is not the *lowest* pass over the ridge, and "yet that it is only at this pass that any one stone from the slate districts has passed into the eastern valleys," and he conjectures the reason to be that "Stainmoor opens to the west and north-west." It will be seen shortly that this is the quarter which all the facts yet observed point to as the most likely source of the materials of the Drift on the western side of the range.

Drift on the East of the Penine Chain.

We may now pass to the eastern side of the central table land, where a plain stretches for some miles with scarcely a trace of Drift. The few exceptions shall first be noted.

Near the northern edge of map 87 S.W., around the villages of Carlton, Royston, and Notton, is a tract of ground ranging from 170 to 250 feet above the sea, whereon lie many pebbles, boulders, and angular blocks of local and foreign rocks. Carboniferous sandstone and gneiss are the most plentiful, but there is no lack of chert from the Mountain Limestone, altered grit, highly metamorphic breccia, felspar porphyry, felstone, basalt, sienite, and granite. The most notable erratic is an angular block of the last, lying in the back street of Royston and used as a mounting-stone; it measures $2' 6'' \times 2' 6'' \times 2' 0''$, and is mainly made up of large crystals and veins of pink felspar, with a great deal of black mica in small specks, and very little quartz. We are informed by several of our colleagues that it resembles very closely the granite of Shap Fell. These boulders are mostly found lying loose on the surface of the ploughed fields, but in one or two cases sections were seen showing them imbedded in stiff clay from one to eight feet thick; and the cutting of the mineral railway, now being made at Blacker Hill, two miles north of Barnsley, is being carried through a mass of Boulder-clay which lies in a hollow in the bedded rocks: the cutting at the middle is 22 feet deep and does not there reach the bottom of the clay.

Again east of Barnsley, and about a quarter of a mile north of Burton Priory, in draining a clayey field they dug out many angular and rounded boulders of Carboniferous sandstone, not, however, the sandstone of the hills hard by; two angular blocks of highly metamorphic black breccia; and one small angular block of a coarse, bedded gritstone metamorphosed into quartz rock. The spot is in the valley of the Dearne, 120 feet above the sea.

Again about a mile north of Rotherham, on the east side of Barbot Hall, the top of a hill, 200 feet above the sea, is covered with a clayey soil containing pebbles of quartz, sandstone, Mountain Limestone, Oolitic rocks, and (?) Magneesian Limestone.

Again, in the railway cutting just north of Masborough Station, in a hollow in the Carboniferous Rocks, there is a little patch of clayey sand containing pebbles of carboniferous sandstone and quartz-rock. Mr. H. C. Sorby, of Sheffield, whose kind help we are glad to take this opportunity of acknowledging, writes word that along the slopes of the Don valley below Rotherham he has found numbers of pebbles of rocks not met with anywhere in the neighbourhood; a common kind is a green, finely grained, hard rock, like a very compact slate or jasper. In the yard of the Rotherham Gas-works is a large heap of boulders, mostly well rounded, some half angular; the larger part are foreigners, granite, many kinds of trap, Mountain Limestone, and Oolitic rocks; some are of carboniferous sandstone. I was told they had been brought out of the streets, but they most likely were first of all gathered off the fields in the neighbourhood; and the large proportion of foreigners is probably due to the fact that these were picked out as being the hardest and therefore the best paving stones.

Near Orgreave, in the valley of the Rother, four miles south of Rotherham, pebbles of quartz rock and other foreigners are occasionally found on the surface; some specimens are in Mr. Sorby's collection.

At Southey House, three miles N.N.W. of Sheffield, is a boulder of black,

* *Illustrations of the Geology of Yorkshire, Part II., p. 162.*

flinty, felspathic rock, at a height of nearly 500 feet above the sea. We again learn from Mr. Sorby that a boulder of green slaty rock was at one time to be seen in a wall near the Sheffield Botanic Gardens; it has lately been carried away; the spot is 400 feet above the sea. Mr. Sorby has also seen fragments of a large boulder found near Renishaw, eight miles south-east of Sheffield.

Our knowledge of the portion of the eastern plain from Sheffield through Chesterfield down to Belper is meagre; we believe we are right in representing it as in the main free from drift, but whether any isolated patches or erratics are to be found on it we cannot say.

East of this driftless portion of the plain, drift again comes on along a line laid down approximately on the map. On reaching this line we find the first traces in the shape of pebbles, mostly of local rocks, thinly strewn over the surface. Eastwards the drift thickens, but for some way is only found in detached patches, seldom more than 20 feet in thickness; and we must go some way further before we find it covering the country so thoroughly as seriously to hide the stratified rocks. In his memoir on the map 82 N.E., Mr. Aveline writes: "It is on the eastern part of the quarter sheet that the drift is in greatest force, being chiefly derived from the breaking up of the pebble beds of the New Red Sandstone. . . . The gravel besides contains fragments of Magnesian Limestone, Coal-measures, and other rocks, very little rounded. . . . Over the western half of the district, though the drift is not so thick as in the east, . . . it is very seldom that the ground is entirely clear of it; for in going over any part of the country where the rocks are well exposed and apparently uncovered by drift, a few pebbles are sure to be seen scattered over the ploughed fields, mixed with fragments of the rock beneath."*

Again, the same author, in his memoir on the map 82 S.E., says: "It is not in many places over this district that the drift is so thick as to prevent our arriving at some conclusion as to the nature of the underlying strata. . . . On some of the hills of Keuper Marl the drift lies very thick, as on Kneesall Hill, where there are from 20 to 30 feet of it, but it is only in patches that it lies so thickly."† Of 71 N.E. our colleague says, "The whole of this country has more or less a covering of drift, not spread uniformly, but in patches."‡

The district over which our knowledge yet reaches is only part of a large tract of country running up to the borders of Scotland, which must be examined before we can hope fairly to solve the problem proposed in the beginning of this chapter. We shall therefore here do no more than point out the direction in which the facts, as far as they are yet known, seem to lead.

The piling up of the Drift against the western wall of the Penine table-land, the manner in which it seems to find its way up inlets and through gaps in the barrier, and its lapping round the southern end of the hills, will all be explained if we suppose the average trend of the currents in the glacial sea to have been towards the south-east. From the absence of Drift over the table land itself it would seem that the depression of the land did not much exceed 1,200 feet. On the east a direction of the currents like that on the west may have prevailed, as suggested by our colleague Mr. Hull, and so kept the Drift which came from the north round an old headland on the east of the Scottish borders, off the eastern slopes of the Penine range. Or this Drift may have come from the north-east, and the supply have been used up before reaching the hills. These explanations, however, are to our mind far from satisfactory. The isolated patches of Drift and the erratics, lying on the driftless part of the eastern plain, may have come through gaps in

* *Geology of Parts of Nottinghamshire, Yorkshire, and Derbyshire (Quarter Sheet 82 N.E.)* Memoirs of the Geological Survey, p. 18.

† *The Geology of Parts of Nottinghamshire and Derbyshire. Quarter Sheet 82 S.E.* (Memoirs of the Geological Survey), p. 14.

‡ *The Geology of the Country around Nottingham* (Memoirs of the Geological Survey), p. 17.

which it has been drawn up are of very unequal authority, these shall first be laid before the reader. In the quarter sheets, 88 S.W., and 81 N.W., the Drift has been mapped by my colleague Mr. Hull, who has kindly sent me a reduced copy of his maps; in 81 S.W. the Drift has also been mapped by the Geological Survey. In 72 N.W. information has been given by Mr. J. Ward of Longton, but the boundary is for the most part conjectural. In 88 S.E., 81 N.E., and 81 S.E., the observations of the Geological Survey have pretty fully proved the absence of Drift, with the exception of the few patches marked; other small detached masses like these may have been overlooked, but this is neither very likely nor very important. In 72 N.E. we have been able to draw an approximate line to the north of which Drift is not found; to the south of this line, though Drift is found in large quantities, the country is not everywhere covered by it; in absence of detailed information the map may be taken as exact enough for our present purpose. Towards the south-west corner of the quarter sheet, however, the line is very doubtful. In 87 S.W. the country has been sufficiently examined by the Geological Survey to make the map trustworthy; the same may in some measure be said of 82 N.W., 82 S.W., and the northern part of 71 N.W.; in the southern part of the latter we are still very much in the dark. In 87 S.E., 82 N.E., and to a smaller degree in 82 S.E., and 71 N.E., the observations of our colleague Mr. Aveline have enabled us to lay down a drift boundary most likely not far from the truth. Generally, however, the shaded part of the map must be taken to show the area within which Drift occurs, but it must not be supposed that the whole of it is covered with Drift.

Heights have been taken where possible from the maps or levellings of the Ordnance Survey; failing these, from the Horizontal Sections of the Geological Survey, from personal measurements, and other sources; they do not claim to be minutely accurate, but are near enough for our purpose.

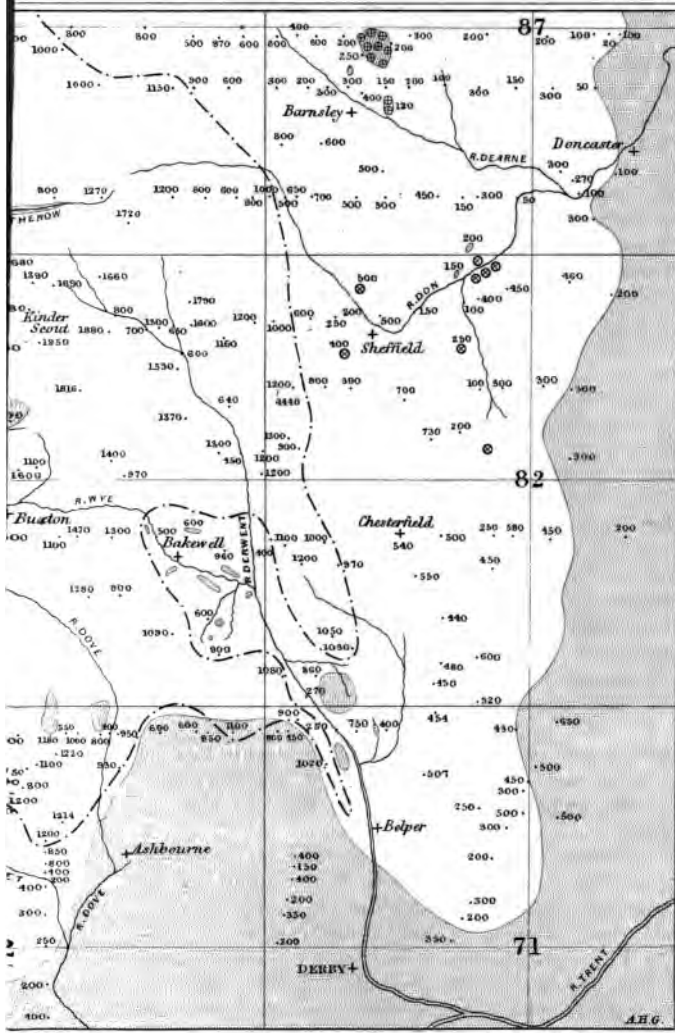
Let us first glance at the shape of the country. In the middle is the tract of high ground forming the southern end of the Penine chain. The outline of this is marked on the map by a strong stroke-and-dot line. Though channelled in every direction by deep valleys, this ground may be looked upon as a table land, bulging up in the centre; its margin has an average elevation of about 1,000 feet above the sea, and the highest points on it fall little short of 2,000. This raised tract is bounded on the west, south, and east by a plain whose average height above the sea is not more than 400 feet. The western descent from the hill country to the plain is steep, because the hard rocks which form the former pass with a high dip below the softer rocks of the latter, or are brought against them by faults. On the east the slope is much more gradual, because the rocks of the high land pass beneath those of the plain with a small dip. On the south the angle of the slope varies with the dip or the nature of the boundary.

The distribution of the Drift over this country is in general terms as follows. On the west the plain is everywhere thickly covered with it, it runs up the slopes of the central tableland, and patches of it and erratics are found on the tableland itself, *along its western margin*, up to a height of 1,200 feet above the sea. The distribution on the south is very nearly the same as along the west side, but the plain is not so completely covered, and the greatest height reached is rather less. With the exception of the patches on its western margin just mentioned, the central plateau is perfectly free from Drift; but in the one case of *a valley which cuts well across it*, that of the R. Wye, there is reason to think that the Drift has found its way through the gap, at all events

show the distribution of the Drift
 of the southern part of the Penine Chain.

Scale 10 miles to an inch.

Plate III.



Drift occurs  Erratics ⊕

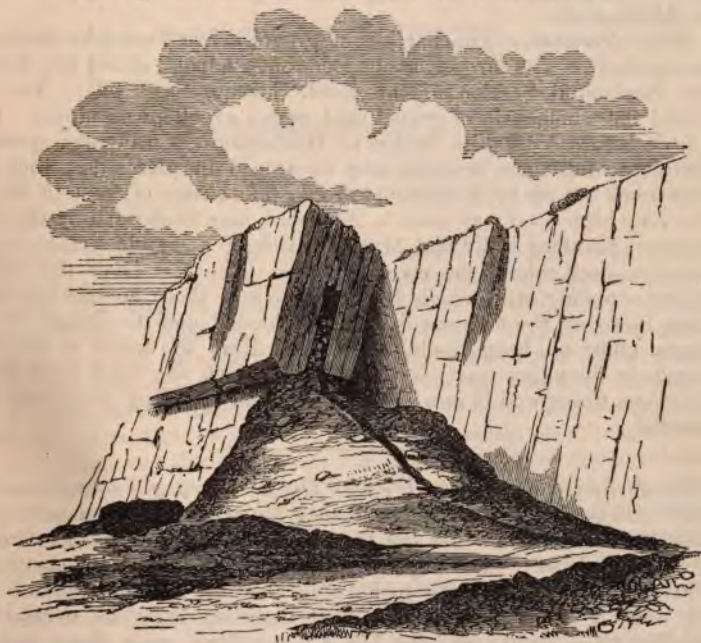
mine Table-land shewn thus — — — — —

ers of the sheets of the one-inch Ordnance Map of England.
 heights in feet above the sea-level.

below the opening rested on solid rock ; this would make the height about 15 feet. At the top of the tunnel was an open space, about big enough for a man to crawl through ; Mr. Wardle told me that it ran on for a little way, and was closed at the end by a wall of rock, covered with stalagmite. Below this open space the tunnel was filled up with a tumbled mass of angular blocks of limestone, often covered with stalagmite ("waterspar" of the quarrymen), mixed with reddish clay. I also found three well-rounded quartz pebbles. The more perfect bones had been carried away before our visit, but we found and saw a basketful of broken bits of bone, mostly small and waterworn. We thought there could be no doubt that this had been an old underground watercourse ; whether the opening to the surface has been quarried away, or whether it is yet to be found, we cannot say.

Fig. 36.

Sketch of the Quarry and Cavern at Waterhouses.



River Deposits.—Narrow strips of river gravel are found along the valleys of the rivers Noe and Derwent.* For the most part they are above the reach of even the highest floods that occur at the present day, and they must have been formed at a time when the volume of the streams was larger than now, and their fall less rapid ; at present the rivers mostly flow in deep channels cut down through their old alluvia well into the bedded rocks below.

River Noe.—The valley of Edale above Edale Mill* has on the north side of the river a broad flat bottom looking very like an alluvial plain ; here and there we find patches of gravel at a little below Edale Mill. The gravel, however, is much mixed up with rainwash, and is not widespread

* In Map 81 N.E.

enough to justify us in mapping the whole as an alluvial flat. From Edale End,* however, down to Mytham Bridge,* a well-marked strip of gravel is found, showing at times two or more terraces. A good section was seen where the road leading from Hope* to Twitch Hill Farm crosses the stream. The gravel is here of all degrees of coarseness down to sand, stratified and false bedded; in it are lumps and a bed of black clay, evidently decomposed shale. Near the river all the stones are rounded, but as we go up the hill the gravel becomes mixed with angular rainwash, and the two pass into one another so gradually that it is hardly possible to draw a good line between them. The village of Hope stands on the highest terrace, at the foot of which the river now flows, with a steep cliff for its bank, which it is undermining and forcing westwards; on the opposite side of the stream the gravels show several terraces.

The valley of the Peak's Hole Water* is somewhat like the upper part of Edale; probably, but not certainly, covered with river deposits; gravel enough, however, was seen to justify us in mapping part of it as an old alluvium.

River Derwent.—The patches of gravel above Yorkshire Bridge are unimportant. The largest, about Derwent Chapel,* shows two terraces (see Horizontal Section of the Geol. Survey, sheet 69). This and indeed the whole strip of gravel land makes excellent meadows. From a little below Yorkshire Bridge to Hathersage* is a broader spread of gravel; two or three terraces may be traced in places, but they have been much cut up by later denudation. The lowest of these in the case of a very high flood, say once in 20 years, may be flooded by the river. Between Bamford Mill* and Mytham Bridge* a double terrace may be traced on each side of the river. Lower down the river the alluvial matter is mainly sand which is seen here and there to rest on gravel. Here, however, the flats are liable to be flooded, and the deposit of sand is now going on, being doubtless derived from the waste of the older gravels in the upper part of the stream, which the river itself formed in bygone times, and is now eating away and grinding down into finer material.

Sands and Clays of the Weaver Hills.—We ought to mention here some curious deposits of sand and clay found on the Mountain Limestone between Caldon and the Weaver Hills.† They were noticed by Mr. Edwin Brown in a paper read before the British Association at Nottingham in 1866. He looks upon them as the remnants of what was once a widespread deposit, and describes them as overlaid by Boulder Clay. Subsequently Mr. George Maw made these and like deposits in North Wales and Tipperary the subject of two papers in the Geological Magazine (vol. iv. pp. 241, 299). His opinion was that they had been let down into pot holes or pipes in limestone formed by the action of acidulated water, and he compared them to the pipes filled with gravel and clay so common in the Chalk.‡ As the country in which these deposits occur does not lie within the district we were called up to resurvey, we have no detailed observations of our own to offer, but one of us was able to pay a hurried visit to one of the pits, a mile and a quarter south of Caldon, and made the following note: "The deposit consists of unstratified masses of clean mottled sand, incoherent pebble beds, and little patches of clay jumbled together;

* In Map 81 N.E.

† In Map 72 N.E.

‡ See also a paper by the same author, Quarterly Journal of Geological Society, vol. xxiii. p. 387.

“ the pebbles are all or nearly all of quartz rock, and have doubtless
 “ been derived from the Pebble beds of the Bunter. Had the pebbles
 “ been of flint instead of quartz this mass would have exactly resembled
 “ the mixtures of brickearth, sand, and gravels that lie on the Chalk. It
 “ has doubtless been formed in the same way, and while the Bunter
 “ yielded the sand and pebbles, the clay is probably the insoluble residue
 “ of the mass of limestone rock which has been dissolved away to form
 “ the pot hole. The only doubtful point is whether the sand and
 “ pebbles were derived directly from an outlier of Bunter Beds, or from
 “ a mass of Drift made up of the ruin of Bunter Conglomerates. I
 “ noticed no Boulder Clay in this pit.”

Flint Implement.—We have to add that a flint flake was picked up by Mr. Richard Gibbs, fossil collector to the Geological Survey, beside the Wheel Stones on Derwent Edge.* It is now in the Jermyn Street Museum.

CHAPTER V.

MISCELLANEOUS.

We propose to give in this chapter a summary of the more important of our observations, and to notice a few matters that do not fall under any of the former headings.

Mountain Limestone.—The facts that have incidentally come under our notice respecting this formation are neither numerous nor well connected, but they tend to overthrow the formal subdivision of the old geologists, Farey, Whitehurst, Watson, and others. According to these observers there are three beds of toadstone, spreading without break over the whole district, and dividing the limestone into four portions, called the first, second, third, and fourth limestones. There would be nothing strange in beds of lava or volcanic ash being very irregular in their occurrence, and the sections in Fig. 8 seem to show that, perhaps with one exception, toadstones are found at different spots on very different horizons, and are of limited horizontal range. Beside the three regular beds the authors mentioned admitted the existence of “chance” toadstones, that is, toadstones of local and irregular occurrence; but it seems likely that all the toadstones partake more or less of this character. These authors also speak of the several limestones as if they each bore some distinctive stamp which enabled the observer to recognize them by character, independently of relative position. With the exception of the upper cherty beds our experience does not tend to confirm this view. Indeed the attempt to identify beds far apart by mineral character alone has been a fruitful source of error, not only here, but also among the gritstones and other parts of the Carboniferous rocks; for instance, the Kinder Scout Grit of the Peak and the Third Grit of Chatsworth were long, and very naturally, looked upon as belonging to the same bed, because each was the lowest coarse grit in its own neighbourhood. The fact that such shrewd observers have fallen into these mistakes shows that for such details as these nothing but careful mapping of the *whole* of the country can be a safe guide, and proves the danger of the old-fashioned method of taking a section here and a section there, and guessing at the probable identities of the beds.

* In Map 81 N.E.

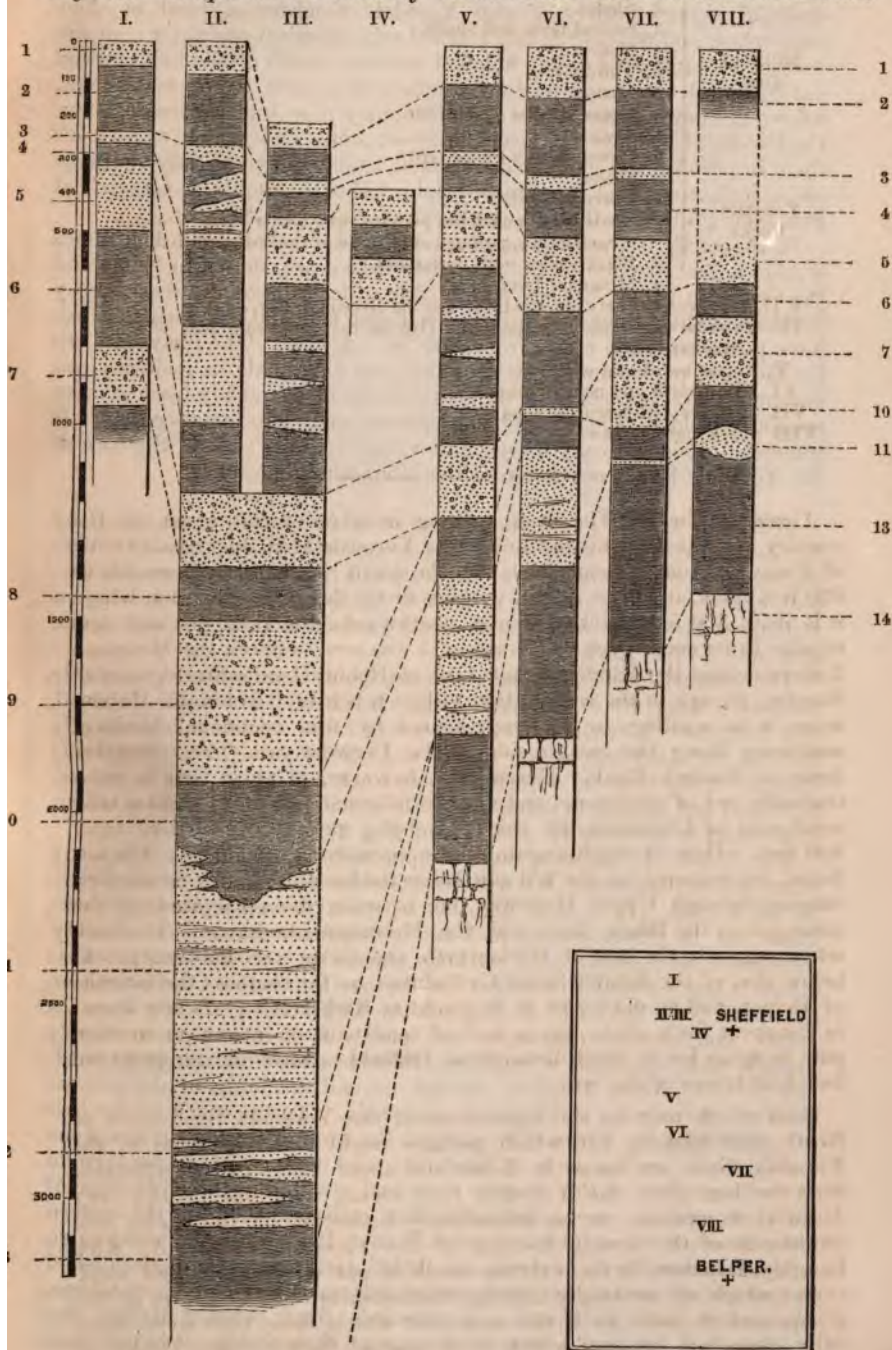
Explanation of Fig. 37.

- | | | |
|--------------------|---|--|
| Millstone
Grit. | { | 1. Rough Rock. |
| | | 2. Shales. |
| | | 3. Second Grits and shales. |
| | | 4. Shales. |
| | | 5. Third Grit. |
| | | 6. Shales. |
| | | 7. Upper Kinder Scout Grit. |
| | | 8. Shales. |
| | | 9. Lower Kinder Scout Grit. |
| Yoredale
Rocks. | { | 10. Shales. |
| | | 11. Yoredale Grit. |
| | | 12. Shales and sandstones perhaps equivalents of the Yoredale Sandstones, perhaps shaly base of the Yoredale Grit. |
| | | 13. Black shales with limestones. |
| | | 14. Mountain Limestone. |
- I. II. III. Sections between Bradfield and the Rivelin valley.
 IV. To show the division of the Third Grit in the south-east part of the Rivelin valley.
 V. To the north-east of Eyam.
 VI. Chatsworth and neighbourhood.
 VII. Ashover and neighbourhood.
 VIII. Crich and Wirksworth.

Yoredale Rocks.—The most striking member of this group in the country described in this memoir is the Yoredale Grit, or "Shale Grit" of Farey. From the moorlands on the north, where it is from 500 to 600 feet thick, it can be traced without break down to Rowsley, where it is about 300 feet thick. Hence, southwards, the rock becomes less regular in its occurrence; no trace of it was seen between the Mountain Limestone and the Kinder Scout Grit of Robin Hood's Stride, west of Stanton, though to the east of that village a belt of it is found. It also seems to be wanting, or only represented by thin occasional bands of sandstone, along the eastern side of the Derwent valley from Rowsley down to Matlock Bank. Hereabouts, however, it again sets in as a traceable bed of sandstone, and may be followed to a point about a mile south-east of Cromford, its thickness being probably not more than 100 feet. Here it begins again to be occasionally wanting; it is not found, for instance, on the hill side below the band of Kinder Scout Grit ranging through Upper Holloway, nor between the escarpment of the same grit at the Black Rock and the Mountain Limestone. The rock sets in again to the east of Wirksworth, and forms a second escarpment below that of the Kinder Scout Grit almost as far south as the latitude of Belper, and an outlier of it is found at Kirk Ireton. It now seems to disappear for a while, but a bed of sandstone on about its horizon puts in again for a short distance at Duffield. South of this point we found no traces of the bed.

Beds which may be the equivalents of the Yoredale Sandstones of North Staffordshire, but which perhaps ought to be included in the Yoredale Grit, are found in Edale and about Bamford. Southwards from the last place the Yoredale Grit seems, with one or two very doubtful exceptions, to be immediately underlaid by the shales and limestones of the lowest division of the Yoredale Rocks. At Kirk Langley, however, in the extreme south of our country, we find sandstones which are strikingly like the Staffordshire representatives of this group, and it looks as if the area over which these beds were originally deposited, or over which they reached their greatest thickness, was a strip of country ranging in a north-westerly and south-easterly direction from this village towards Macclesfield. Along such a belt we find the representatives of the group present in force, except where

Fig. 37.—Comparative Sections of the Millstone Grit and Yoredale Rocks.



Plan to show the position of the sections.
Scale, 20 miles to an inch.

Scale, 500 feet to an inch.

they have been removed by upheaval and denudation ; to the north of it, on the eastern side of the Penine anticlinal, there are only a few doubtful representatives of the Yoredale Sandstones, local in their occurrence, and wanting in any marked mineralogical character ; on the west of the anticlinal we do not find sections north of the belt marked out cutting deep enough to show whether these beds are present or not, till we get beyond the limits of the country now under consideration. On Pendle Hill, however, near Clitheroe, sandstones which agree with them in position and character are found, and we have already ventured on a conjecture that the Wensleydale "Hawes Flagstone Group" of Professor Phillips is the representative of these beds.*

In the north of the present country the black shales and limestones of the lowest division of the Yoredale Rocks are shown in Edale and the Castleton valley, but we were unable to form there any trustworthy estimate of their thickness. Between Eyam and Matlock several mines have proved them to range from 330 to 400 feet. The limestones are for the most part concretionary, or thin and found only in nodules ; but here and there, especially in the south of our district, they become more regularly bedded, thicker, and so numerous and close together that it is somewhat difficult to say whether they ought to be put at the base of the Yoredale Rocks or the top of the Mountain Limestone.

Millstone Grit.—The topmost bed, or Rough Rock, is, as usual, by far the most constant member of this group both in thickness and character. Its average thickness is 100 feet, and it is a massive, coarse, felspathic, and therefore crumbly gritstone. One notable exception happens at Hollow Meadows, where it is finely grained and flaggy, and at one spot only 25 feet thick.

The Second Grit is for the most part feebly represented by a single sandstone from 20 to 40 feet thick. But about Bradfield, Fulwood, and Longshaw it swells out and contains several sandstone beds largely worked for building stone, flags, and tilestones. The remarkable changes in the beds between the Rough Rock and Third Grit have been described and figured in detail on pp. 62–64 and in Fig. 21 and are shown in abstract in Sections II. and III. of Fig. 37.

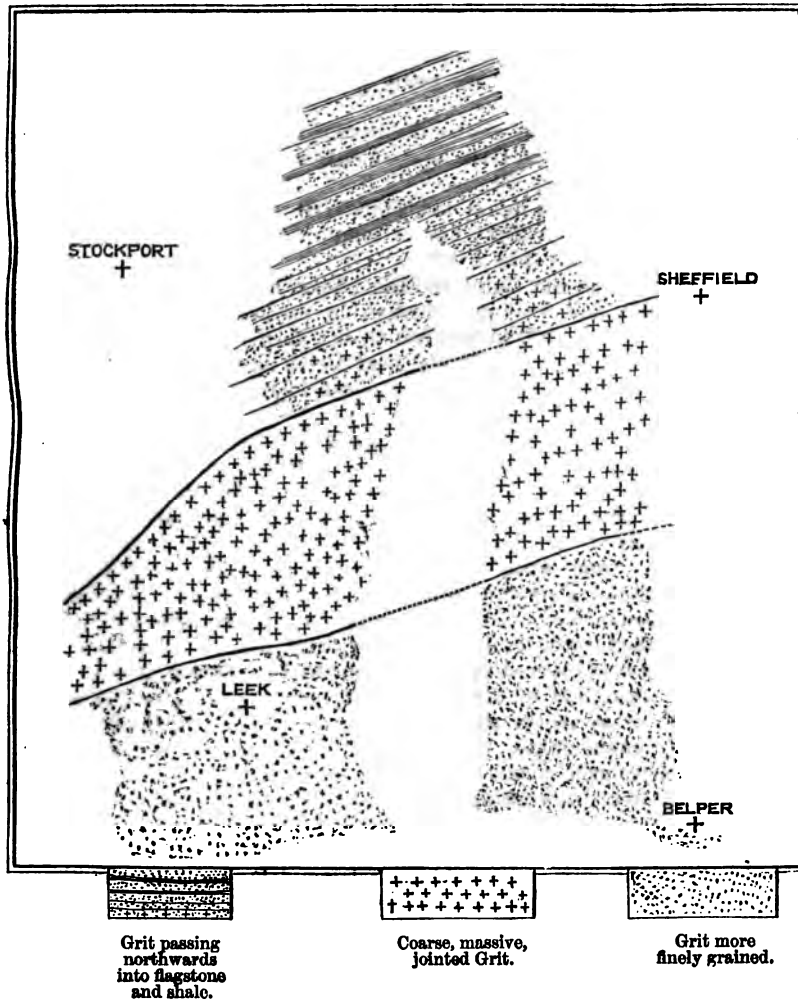
The Third Grit shows a more complicated set of changes than any other bed of the group. We will first consider its character in the centre of the district. It is there the coarse, massive, well-jointed gritstone, often red in colour, whose look and escarpments have been already mentioned as forming such striking objects in the landscape. This stamp it bears from Crow Chine on the north to below Chatsworth on the south. To the north of this belt the Third Grit gradually loses its coarse and massive character, and passes first into a more closely grained rock, then into a sandstone thickly bedded but finely grained, and at last around Dunford Bridge, beyond the limits of the present country, into a mass of flagstones and shale. To the south of the belt of coarse rock the Third Grit puts on the form of a reddish sandstone rarely coarse, and in beds of moderate thickness. Now if we turn to the western side of the Penine anticlinal we find a threefold type of the rock exactly corresponding to that just described for the eastern side. Between the neighbourhood of Whaley Bridge and the hills known as the Roaches north of Leek, the Third Grit cannot be distinguished in any one of its marked characteristics from the grit of Crow Chine, Hathersage, and Chatsworth. Northwards from Whaley Bridge the rock changes gradually, but on the east of Staleybridge it is just such

* *Geology of the Country round Stockport, Macclesfield, Congleton, and Leek (Memoirs of the Geological Survey)*, p. 83.

as we find it in the neighbourhood of Dunford Bridge. From the latitude of the Roaches southwards it puts on very much the form it wears over Beeley, Darley and Tansley moors. These facts are roughly depicted on the map below.

Fig. 38

Map to show the different character of the Third Grit.



Scale, 10 miles to an inch.

These three types of rock point to different conditions of the sea bottom on which they were laid down. The researches of Mr. Sorby have shown that the coarse grit was most likely formed in a comparatively shallow sea along the bottom of which the heavy materials of which it is made up were rolled forward by currents, and he has further found out that the current-bedding over the area covered by the coarse

grit proves that the current which drifted the sediment came from the north-east. The map shows that the belt of coarse grit has the same bearing, and it may be that this ground was formerly the termination of a long shoal in the Millstone Grit sea, reaching from the land, whose waste furnished the materials for the gritstones, up to what is now the centre of England. To the north and south of this shoal the water may have been deeper. With this arrangement of the sea bottom coarse sand and pebbles could be swept along for considerable distances, even as far as our present district, over the belt of shallow sea; while in the deeper water to the north and south of it the currents would have less power, and would be able to bring only mud and finer sand; and the result would be a band of coarse grit and conglomerate in the middle, shading off into more finely grained beds to the north and south.

Section IV. of Fig. 37 shows the local thickening and division by a shale band of the Third Grit at the south-eastern end of the Rivelin valley, described on page 71.

The coal lying on the top of the Third Grit is very generally present its average thickness is 2' 6", but at some spots it is as much as 4' 6" and at others not more than 1' 8."

The beds between the Third and the Upper Kinder Scout grits show very remarkable and irregular changes in thickness. In the extreme north they are from 200 to 300 feet thick; they swell out southwards to more than 500 feet; and finally, near Crich and Belper, come down to 80 or 90 feet. Where thickest some considerable beds of sandstone are interbedded with the shales.

The Upper Kinder Scout Grit behaves in a still more remarkable way. On the north it is a very coarse and massive gritstone, up to 200 feet thick. North of Hathersage it undergoes considerable change, and though still in places thickly bedded and coarse, it is in the main finely grained and mixed up with shale; it somewhat recovers its coarseness on Eyam Moors, and again about Stoney Middleton changes into finely grained sandstone; it continues to fall off in thickness and coarseness, till in Chatsworth Park it dies away, or very nearly dies away, altogether. It then recovers itself rapidly, and from Beeley down to Morley, where it is covered up by the New Red Sandstone, it is again a massive gritstone, 150 to 200 feet thick, not perhaps upon the whole quite so coarse as in the extreme north, but yet at times very rough, and even a conglomerate. These complicated changes are doubtless owing to some such causes as brought about the like changes in the Third Grit; but the working out of the problem must be left to local observers.

Traces of coal, for the most part very thin, are found here and there on the top of this grit; about Alderwasley and Belper, however, there is a seam, 1' 6" thick, which was once gotten.

The case of the Lower Kinder Scout Grit is far simpler. We find it on the north a mass of coarse, very thickly bedded gritstone and conglomerate, 400 feet or more in thickness; it keeps its character, and as far as we can judge its thickness, till the southern end of Bamford Edge, dies away there very suddenly, and no traces of it are seen again.

As on the other side of the Penine anticlinal,* traces of coal are found on the top of each of the gritstone beds, and we have moreover noticed that the surface of each is in many cases seen to have been

* The Geology of the Country round Stockport, Macclesfield, Congleton, and Leek (*Memoirs of the Geological Survey*), p. 85.

waterworn before the overlying shales were deposited upon it; these facts tend to confirm our former notion* that an interval occurred between the deposition of each sandstone and the shale above it, during which the former became a land surface.

The changes in the gritstone group just described are plotted to scale in the sections on fig. 37. If this be compared with the fellow woodcut for the other side of the Penine anticlinal, given on page 85 of the memoir on the country round Stockport, Macclesfield, Congleton, and Leek, it will be seen that both show distinctly a great decrease in the thickness of the whole as we go southwards; but that, while in the one case this, both for the whole and for each separate division, is uniformly in the same direction, in the other the several beds show no such regular thinning out, and that some of them even thicken southwards. It may be that matters are exactly as they are represented, but we are inclined to think that, had the amount and detailed character of our knowledge been the same in both cases, the figure for the west would have shown very much the same want of symmetry as that for the east.† Be this as it may, both show clearly that thinning away southwards of the Carboniferous Rocks *as a whole*, which has been so ably pointed out by our colleague Mr. Edward Hull;‡ but one at least shows that the shape of each bed is not that of a wedge tapering uniformly away. We say this because passages might easily be quoted in which some little local southerly thinning of an individual bed is quoted in support of the theory, quite regardless of the fact that the very same bed would, if followed a little further, be found to thicken to the south; as far as it has yet been tested, that is, for the midland and north-midland counties, the doctrine rests on very good general grounds, but attempts like these to push it too far only tend to hinder its acceptance.

Joints.—The gritstones, especially the Third, are well suited for observations on the laws which govern the direction of joints. As an instance we will take the Third Grit of Stanage Edge (see p. 78). On the map, Fig. 39, page 144, the position and directions of a number of measured joints are laid down, the rays of each star-like figure showing the bearing of the joints observed at the centre of the star. We see from this map that the joints have roughly a tendency to arrange themselves parallel to two fixed straight lines, but this will be rendered still more clear by the following artifice. If from the centre of a fixed circle we draw lines parallel to the directions of the joints, and if, where there are several joints having the same bearing, we make the corresponding spoke proportional in breadth to the number of these joints, we shall obtain the diagram in Fig. 40, page 145. In the map, which shows both the bearing and geographical position of the joints, it is somewhat difficult to carry the eye from one set to another; but by referring them all to one centre in the diagram, we see more clearly the relations which these compass-bearings have to one another, and can deduce the laws, if there be any, which govern them.

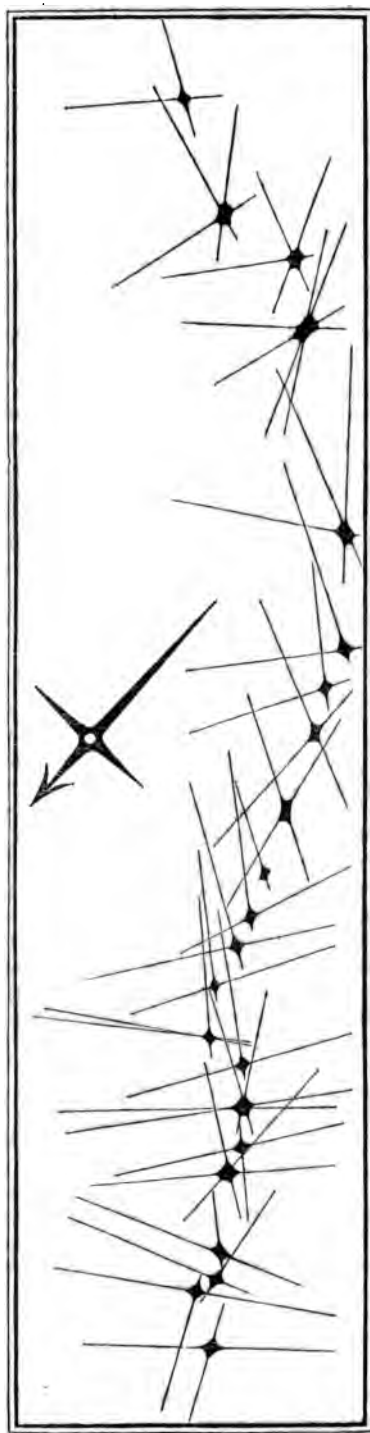
The diagram now shows us that the joints arrange themselves in two sets, and show a tendency to cluster round two lines bearing roughly north-east and south-east, which are about the directions of the dip and strike of the rock. The first set are less numerous, but keep closer to the mean bearing than the second. While in the first case, however,

* Do. p. 86.

† As both these woodcuts are by the same hand, he may be allowed to say that he is here criticising only his own work.

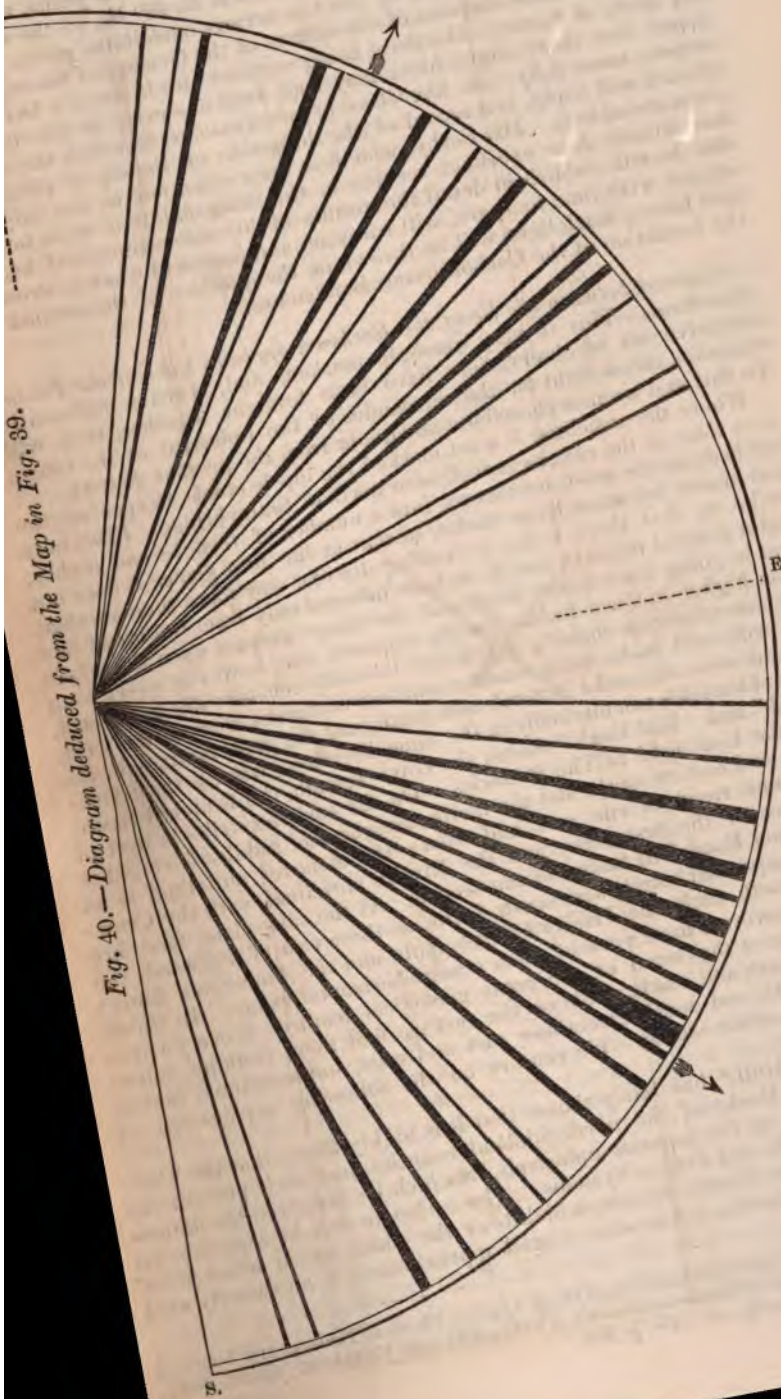
‡ Quarterly Journal of Geological Society of London, vol. xviii. p. 127.

Fig. 39.
Map showing the Position and Bearing of Joints on Stanage Edge.



Scale, 4 inches to a mile.

Fig. 40.—Diagram deduced from the Map in Fig. 39.



the largest number of joints which have the same direction is four, pointing E. 60° N., in the second case we have six joints, ranging E. 40° S. The mean direction of one set is E. 46° N., of the second, E. 43° S.; these are shown by the two arrows outside the circle.

The time at the disposal of the officers of the Geological Survey does not allow of matters like these being entered into in detail; but it is hoped that these slight hints may lead local observers to take up the subject more fully. A like class of observations, to which the same remark will apply, is a record of the directions of the dip of planes of current-bedding. Mr. Sorby, who first drew attention to the subject, has already done excellent service in this line, and it is to be hoped that he will publish in detail the results of his observations; if he, or anyone with time to spare, will carry on and complete what is already well begun, much light will be thrown on the question of the method of the formation of the Carboniferous Sandstones.

Contrast between the lie of the Rocks on opposite sides of the Penine Anticlinal.—This is very strongly marked, and, when a sufficiently extensive set of observations have been brought together, they will doubtless throw light on the mechanics of the upheaval of the range. To this end we now contribute our quota from the present district.

Where the anticlinal is most marked the dip is much steeper on the west than on the east, as is well seen north of Staleybridge. Elsewhere the beds on the west are thrown into a number of troughs and arches, and broken by many large faults, so that at the first glance it does not strike us that there is any prevailing dip one way more than another, and a general easterly rise is at least inferred only from the broad fact that in going towards the centre of the range we pass upon the whole from higher to lower beds. On the opposite side, however, every long transverse section shows a gentle and tolerably constant dip to the east, the rolls and faults being smaller and less numerous than on the west. On the west the strike is north and south, and the great faults with the axes of the folds run markedly in the same direction; witness the "Anticlinal" and "Red Rock" faults, the Goyt Trough, the Rudyerd Basin, and the Coal-field of The Potteries. On the east the strike is west of north and east of south, and the faults, troughs, and saddles have either the same trend or run east and west; the Ashover anticlinal is an instance of the first class, and the Rivelin anticlinal, with the Crawshaw and Rood Hill basins, of the second. At the same time, there are some important north and south faults, as those east of Fulwood, the Chatsworth fault, the Trinity Chapel fault, and the Ambergate fault; these, however, have none of them a large horizontal range. In short, on the west the trend of the great geological features is everywhere nearly north and south, while on the east we find them running sometimes north and south, sometimes east and west, and sometimes taking an intermediate course. We venture on the following explanation of these facts.

Mr. E. Hull* has lately shown that it is highly likely that the Carboniferous Rocks of the north-midland counties had their present lie given them by two separate upheavals, to which he has given the names of the Pendle and Penine Systems. The earlier in date he supposes to have been the Pendle System, which bent the rocks into a number of troughs and arches, whose axes ranged approximately in an easterly and

*Mr. E. Hull, on the Relative Ages of the Leading Physical Features and Lines of Elevation of the Carboniferous District of Lancashire and Yorkshire. *Quart. Jour. Geol. Soc. of London*, vol. xxiv. p. 323.

westerly direction. Then followed the Penine upheaval, acting along northerly and southerly lines. Now the excess of contortion and disturbance, and the greater steepness of dip, which we find on the western side of the Penine Chain, seem to show that the force, whatever it was, which brought about the later system of disturbance, had its starting point on the west, and that its effects became less and less felt as they were transmitted eastwards. On what then is now the western side of the Penine anticlinal it may well be that the later or Penine upheaval may have been strong enough to wipe out completely all traces of the earlier system of easterly and westerly folds, and to give to the rocks their present northerly and southerly trend. On the east of the Penine Range, however, where the later upheaval acted with less intensity, the two systems were more evenly matched, and the lie of rocks will sometimes follow one, sometimes the other, and sometimes share in both directions, as local circumstances may determine.

Rivers and Valleys.—A word must be said touching the eccentric behaviour of rivers, which seem in many cases to have, as it were, purposely gone out of their way to find difficulties, and picked out the hardest rocks and the most formidable ridges to cut through, like giants rejoicing in their strength, and looking down upon easy tasks as unworthy of their prowess.

The valleys may be divided into three classes.

1st. Those which run more or less across the strike, cutting through escarpments and whatever stands in their way with a total disregard to the present configuration of the surface.

2nd. Those which run parallel to the strike.

3rd. The lesser gorges, feeders of both classes.

Of the first class there are many instances, none perhaps more marked than the valley of the Derwent at Matlock. The river has flowed from Rowsley along a broad shale valley, and about a mile before reaching Matlock strikes up against the limestone, which rises like a wall across its path from the broad flat of the alluvial plain. A stream of water set going down such a valley would, one would think, be turned aside by such a block in its path, and, bending a little to the east, would run on round the outskirts of the limestone in the soft shale. But in this wall of rock there is a breach, only one, and that so narrow that it had to be enlarged by blasting to admit the turnpike road into the valley, and through this rift the Derwent enters and flows in a deep, steep-sided gorge down to Cromford, where it again comes forth into a broad shale valley. We could not find a better illustration of Colonel Greenwood's doctrine, that "as sure as there are alternations of hard and soft strata" in the course of a river or valley, so sure will there be alternations of "gorge and alluvial flat." But now comes the question what made the breach and gorge? One school say, when the limestone stood up as a rock in the sea the waves cut the passage through, which the river afterwards appropriated to its own use; another school that a river has done it all; that once the wall of limestone did not exist, the shale on the northern side reaching up to or far above its top, and that in this comparative flat some accidental depression determined the course of a stream, which cut a channel step by step deeper and deeper; that, where the valley thus formed ran through soft shale it was widened out by the help of rain and tributary brooks, but that in a hard rock it kept more nearly the trench-like character with which it began. Many more such cases might be pointed out, such as the entrance of the Dove into the limestone at Beresford Hall, and of the Manifold into the

same rock at Apes Tor near Ecton, where the contrast between the shale flat and the limestone wall, and the breach in the latter, are most striking. On either theory it is likely, and on the latter certain, that these transverse valleys are the oldest of the three classes.

The largest case of a transverse valley is that formed by the river Wye and the portion of the river Derwent below its junction with the former. This hollow, though here and there running parallel to the strike and at the foot of an escarpment, as a rule pays no regard to dip, comparative hardness of beds, or present shape of the surface, but cuts across everything that comes in its way; we therefore think that this is the oldest and was once the main line of drainage, and that the upper part of the Derwent, which partakes more of the character of the second class of valleys, was formed later, and was at first only a feeder of the main stream.

We may also notice that the brooks between Chapel-en-le-Frith and Glossop, on the western side of the great watershed, have all cut through the ridge formed by the easterly outcrop of the Millstone Grits of the Goyt Trough, and so found their way into the Goyt or Etherow, while, if they had been guided by the present surface configuration of the ground, it seems more likely that they would have flowed, some to the north, and some to the south, along the valley at the foot of the ridge, and the latter would have gone down the Doveholes valley into the Wye. In the case of Glossop Dale and the Hayfield Brook there are faults ranging along these cross valleys, but there are at least three other valleys, quite equal to these in size, which are free from any disturbance.

The second class of valleys, those which run parallel to the strike and often lie between two escarpments, have been mentioned in the introductory sketch of the general shape of the grit country, and are illustrated in fig. 1. Among other writers Messrs. Topley and Foster have explained how these valleys may grow into existence as feeders of the transverse valleys;* and a conjectural explanation of the method of their formation in the present country was put forward in the memoir on the country round Stockport, Macclesfield, Congleton, and Leek (p. 87). The clean sandstone dip-slopes of these valleys are very noticeable, and observations in the present district have tended to strengthen our belief in the explanation quoted. One of the best illustrations is found in the neighbourhood of Strines (north-east part of map 81 N.E.). A transverse feeder of the Bradfield Dyke there cuts across the Upper Kinder Scout and Third Grit; two of its tributaries, one running along Hollindale, and the other at the westerly foot of Strines Edge, belong to the second class of valleys. Both brooks flow for long distances just on the top of the Upper Kinder Scout Grit, with a steep slope of the overlying shales for their eastern bank; the lower part of this slope is a cliff with a raw, freshly cut face, and at the bottom are heaps of newly fallen shale, which the stream is grinding down and carrying away; and we see clearly the process in action by which the side of the valley is being worked back, and the valley widened to the east, exactly after the fashion described in the passage referred to above.

When a valley of the second class has grown into sufficient importance rivulets will begin to trickle down into it, especially on the steep or escarpment flank. These are always cutting their way back into the hill, and thus in the course of time become transverse valleys of con-

* Quarterly Journal of Geological Society of London, vol. xxi. p. 470.

siderable size, and will have in turn feeders of their own of the second class; and by such a branching system, taking its rise originally from one great transverse valley, and ever spreading and pushing out new arms further and wider over the land, the moulding and carving of the present surface may be supposed, without any extravagant assumption or any great degree of improbability, to have in great measure been brought about.

Landslips.—Many cases have been noticed in the course of the memoir, at the foot of hillslopes formed of soft shales and capped by massive sandstones. Frost, springs, and underground streams soften and carry away the shales, and huge masses of the sandstone, thus deprived of their support, break off along joints, and slide or topple down into the hollow below. This happens especially in the case where the dip is down into the valley, for then the rain which percolates through the porous sandstone is checked in its course downwards on reaching the impervious shale, and flows out along the plane of junction of the two; and so this floor, whose slope already gives the sandstone a tendency to slide, is made slippery, and the friction and cohesion, which alone keep the rock in place, are lessened or destroyed, and a fall ensues. This process seems to have gone on till equilibrium was established, and many of these slips and the hills above them must have been for a very long time in state of perfect rest. Instances are known, however, where such ground has been tampered with by artificial cuttings, and a renewal of the movement has followed; and any small change in the natural conditions of the country would certainly have the same effect. Landslips also of large size have happened within this district in the memory of man, and many cases of the wearing away of hills, as at Mam Tor, are now going on every winter or rainy season; so that, in spite of the outwardly settled look of the face of the land, we are assured that the same causes are at work and the same effects resulting from them as in times long gone by.

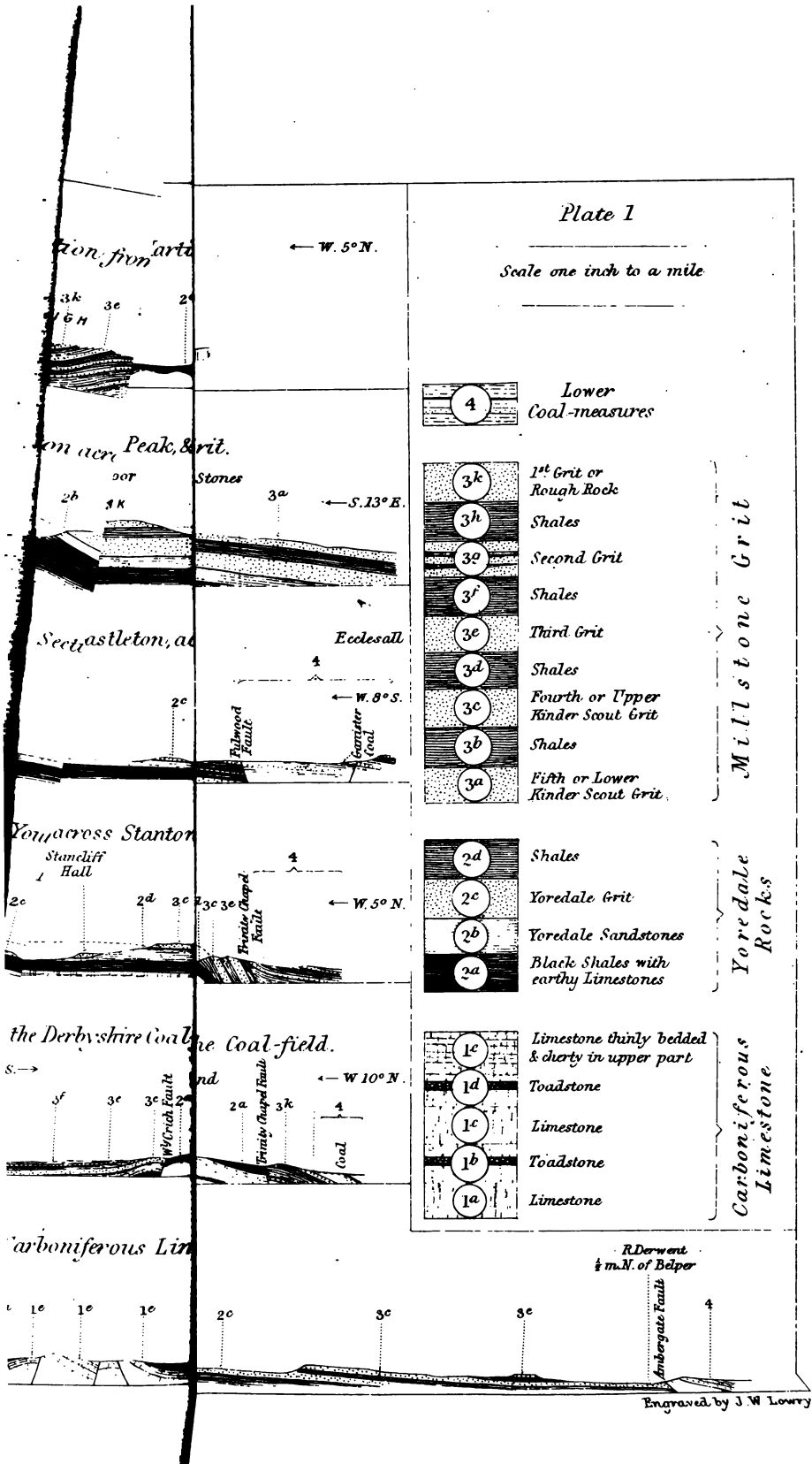
Other points of connexion between the shape of the ground and its geological structure have been already noticed, or are too obvious to call for detailed description. The basin-shaped lie of the beds in outliers is well illustrated by the case of the Peak. It is doubtless to this accident that we owe the preservation of the capping of grit to the hill; had the dip been from, instead of towards the centre, that is, had the beds been domed instead of being basin-shaped, landslips would long ago have brought down a large portion of the rock, which now reposes without any risk from this source at least. Landslips have happened where, for a short distance, the dip has the right direction, and would have been found all round the outlier, had a corresponding dip obtained elsewhere. But, though safe on this score, the grit capping is being slowly carried away by other means, and the time may come when this splendid outlier shall be reckoned among things that have passed away. The brooks that gash the escarpment are always undermining the cliffs of rock at the top and bringing down masses of grit to grind small and carry away, and, by thus working their way back into the table land, will split up its now unbroken flat into a number of separate outliers, each fated in its turn to be cut up by new rivulets, and at last perhaps to be carried away altogether. In this way we can conceive that the Kinder Scout Grit has been cleaned bit by bit off the plateau of Yoredale Grit that surrounds the Peak, and that the few patches that do remain have only contrived to outlive for a time the wholesale removal of the rock in virtue of the basin-shaped arrangement of their beds.

As an exactly opposite case to the Peak we may take the ridge at Coumbs Wood two miles S.S.E. of Matlock. This ridge is capped by Yoredale Grit, and an anticlinal ranges along it, the beds dipping on both sides away from the highest line.

On each side the whole of the sandstone has slipped away in huge masses into the valley below ; and it is only along the crest of the saddle, where the beds lie flat, and have no tendency to slide, that a narrow strip of the rock remains.

Plate 1

Scale one inch to a mile



Engraved by J.W. Lowry

APPENDIX.

ON THE FOSSILS OF THE CARBONIFEROUS LIMESTONE OF DERBYSHIRE.

By ROBERT ETHERIDGE, F.R.S.E., F.G.S., PALÆONTOLOGIST TO THE
GEOLOGICAL SURVEY OF GREAT BRITAIN.

No attempt has hitherto been made to assemble or bring together the Fauna of the Carboniferous Limestone and other members of the Carboniferous formation in Derbyshire, although there are scattered notices in various memoirs and papers, which casually mention the names of species which have from time to time been collected or described in connexion with any particular locality, or may have been collected and now deposited either in public or private collections.

The accompanying table has been drawn up or constructed with the view of bringing together all the known species occurring in the Mountain Limestone, and also from the most important localities in Derbyshire; doubtless a much larger number will be obtained when the county has been thoroughly searched and geologically examined, but it is believed that the accompanying table contains all the known species accessible at the time it was constructed, and therefore fairly expresses the Fauna of the Carboniferous Limestone in those localities named.

The column headed Derbyshire, however ambiguous or unsatisfactory it may appear, as wanting in exactness, has nevertheless some value if aiding only as a stimulant to local collectors to fix the precise locality of the species named; and also shows the necessity and importance of fixing the precise place where authenticated species occur, the term Derbyshire having comparatively little value, although the species have been all collected in the county. The remaining 12 localities all contain forms of life; and, doubtless, closer research will reveal nearly all if not the whole of the species of *Mollusca* in the column headed Derbyshire, in any one of the 12 named. The same remarks may not apply to the *Cœlenterata* (corals), which group had a more limited range than the *Mollusca*, and were, as now, more localised in space, occupying very definite areas during life. This applies to the Fish also, but in a different degree, their nomadic habits causing them to be widely diffused and distributed geographically.

Cœlenterata.—The Limestones of Derbyshire have yielded no less than 54 species of Fossil corals, the localities of 11 only of which are correctly known; critically speaking, it may be said that the remaining 43 have no geographical value, although well known to be species occurring in the Carboniferous Limestone of the county.

Echinodermata.—A large assemblage of Echinodermata, chiefly crinoidea, are found throughout the Limestones, 27 species being known; only 6, however, of this group are strictly localised, and as yet require a habitat. A marked contrast in the distribution and abundance of species in this group is exhibited between the Derbyshire and Staffordshire beds, the latter possessing only (as far as we know) two genera and three species; whereas the Derbyshire Limestones have yielded nine genera and 27 species. This extreme difference may arise from accidental collecting, and more complete researches made into and over this one area, as compared with the other; or to subsequent metamorphism of the Limestones, thus causing obliteration of much if not all remains of life over given areas.

This apparent difference in amount of life in other groups is equally remarkable, and yet throughout the two counties the physical structure of the great mass of the Limestones is the same, having the same mineral and petrological character and aspects. In this particular group, however, difference of habitat is expected from the nature of their functions and habits.

Crustacea.—The distribution of the Crustacea is better understood, 12 out of the 15 species having their localities determined.

The *Brachiopoda* also are somewhat more complete, this arising partly from the number of individuals usually occurring in the species, and also from the greater amount and completeness of investigation this group has undergone through the energy of local collectors and the researches of Mr. Davidson, whose great and valuable labours and researches into the history and structure of this class of Mollusca has been almost exhaustive. 18 genera and 96 species have been determined from Derbyshire alone, and the same number appear to have been found in the Mountain Limestones of Staffordshire; thus conclusively showing the concentrated, local, and gregarious habit of this group, and their abundance through the Limestones of the two adjoining counties.

Lamellibranchiata.—*Monomyaria*.—29 species of this group (*monomyaria*) occur, and are chiefly confined to and distributed through the Limestones of Longnor and Park Hill, a district extremely rich and prolific in the Mollusca.

The Dimyarian *Lamellibranchiata* are rich in genera but poor in species, and occur in the proportion of 21 to 28. This still shows how rich must be the Fauna of the Derbyshire Limestones, if systematically searched and worked in ascending orders, there being at present scarcely more than one representative species to a genus. The Staffordshire beds, as we should expect, exhibit almost the same result, but with fewer genera and more species, or as 15 to 40. Localities that require careful search are Crich, Cromford, Matlock, and Bakewell, for whatever meaning or value may be attached to the broad term Derbyshire, as to exact locality, our researches show that the Limestones at the above-mentioned places are either poor, or that they have never been thoroughly examined.

Gasteropoda.—The table shows that we have 18 genera and 55 species of this class distributed through the Carboniferous Limestone; by no means so large a specific list as that known from the Staffordshire rocks of the same age. The Pelagic Nucleobranchiata are represented by two genera. *Bellerophon* occurring in many localities, and *Porcellia* in two.

The class *Pteropoda* appears not to have been noticed or collected by any observers, although the genus *Conularia* is widely and generally distributed through the Carboniferous Limestones of Britain.

Cephalopoda.—The most careful research has failed to discover more than 31 species of this class, which range through six genera. Upwards of 50 species have, however, been collected from the Staffordshire Limestones. In Derbyshire, *Orthocera* and *Goniatites*, with *Discites* (sub-genus of *Nautilus*) are the most abundant; whereas the genus *Nautilus* is far more largely represented in the bordering counties. The pelagic habits of this group will readily account for their unequal distribution.

Pisces.—The knowledge we possess of this group is chiefly due to the researches of Professor M'Coy, who described and named the series contained in the Cambridge University Museum; want of locality for 8 out of the 12 species renders them of less value in a stratigraphical point of view, and we must, till better known, retain the wide term Derbyshire for their locality.

A few forms collected by Mr. A. H. Green, from the Lower Coal Measures or Gannister beds, the Millstone Grit, and Yoredale Rocks, amounting to 14 species, are embodied in their proper place in the text of the memoir, as being there of more value than if added to the catalogue.

R. ETHERIDGE.

FOSSILS.

	Dorsetshire.	Castleton.	Chrome Hill.	Park Hill.	Longnor.	Pilsbury.	Alstonfield.	Dovedale.	Crich.	Cromford.	Mutlock.	Bakewell.	Ashford.
FOSSILS.													
Sub-Kingdom— CELENTERATA.													
Class—ACTINOZOA.													
<i>Alveolites septosa</i> , Flem.	-	-	x										
<i>Amplexus coralloides</i> , Shy.	-	-	x										
" <i>Sowerbyi</i> , Phill.	-	-	x	x				x					
<i>Astræa carbonaria</i> , M'Coy	-	-	x									x	
<i>Aulacophyllum</i> , sp.	-	-	x										
<i>Chaetetes septosus</i> , Flem.	-	-	x										
sp.	-	-	x										
<i>Cladoconus bacillaris</i> , M'Coy	-	-	x					x	x				
" <i>brevicollis</i> , M'Coy	-	-	x										
" <i>crassus</i> , M'Coy	-	-	x										
<i>Clissophyllum bipartitum</i> , M'Coy	-	-	x										
" <i>coniseptum</i> , Key	-	-	x										
" <i>Keyserlingii</i> , M'Coy	-	-	x										
" <i>prolapsum</i> , M'Coy	-	-	x										
" <i>turbinatum</i> , M'Coy	-	-	x										
<i>Columnaria laxa</i> , M'Coy	-	-	x										
<i>Cyathaxonia cornu</i> , Mich.	-	-	x										
" <i>costata</i> , M'Coy	-	-	x										
<i>Cyathophyllum expansum</i> , M'Coy	-	-	x										
" <i>Murchisoni</i> , M. Edw.	-	-	x	x									
" <i>paracida</i> , M'Coy	-	-	x										
" <i>regium</i> , Phill.	-	-	x									x	
<i>Cyathopsis fungites</i> , Flem.	-	-	x										
<i>Dendropora megastoma</i> , M'Coy	-	-	x										
<i>Fistulipora major</i> , M'Coy	-	-	x										
" <i>minor</i> , M'Coy	-	-	x										
<i>Heterophyllia grandis</i> , M'Coy	-	-	x										
" <i>ornata</i> , M'Coy	-	-	x										
<i>Lithodendron affine</i> , Flem.	-	-	x										
" <i>fasciculatum</i> , Flem.	-	-	x										
" <i>irregularare</i> , Phill.	-	-	x										
" <i>juncum</i> , Flem.	-	-	x										
<i>Lithostrotion Flemingi</i> , M'Coy	-	-	x										
" <i>irregularare</i> , Phill.	-	-	x										
" <i>Major</i> , M'Coy	-	-	x										
" <i>M'Coynianum</i> , M. Edw.	-	-	x									x	
" <i>Portlocki</i> , M. Edw.	-	-	x										
" <i>striatum</i> , Flem.	-	-	x										
<i>Lonsdaleia duplicata</i> , Mart.	-	-	x										
<i>Michelinia glomerata</i> , M'Coy	-	-	x										
" <i>tenuisepta</i> , Phill.	-	-	x					x					
<i>Mortieria vertebralis</i> , Kon.	-	-	x										
<i>Nematophyllum arachnoideum</i> , M'Coy	-	-	x										
" <i>clisioides</i> , M'Coy	-	-	x										
" <i>decipiens</i> , M'Coy	-	-	x										
<i>Sarcinula placenta</i> , M'Coy	-	-	x										
" <i>radiata</i> , Mart.	-	-	x										
" <i>tuberosa</i> , M'Coy	-	-	x										
<i>Stenopora tumida</i> , Phill.	-	-	x										
<i>Strombodes conaxia</i> , M'Coy	-	-	x										
" <i>emarciatum</i> , Fisch.	-	-	x									x	
" <i>floriforme</i> , Mart.	-	-	x										
<i>Syringopora catenata</i> , Mart.	-	-	x										x
" <i>geniculata</i> , Phill.	-	-	x										
Sub-Kingdom— ANNULOSA.													
Province I.—ANNULOIDA.													
Class—ECHINODERMATA.													
<i>Actinocrinus globosus</i> , Phill.	-	-	x										
" <i>longi-spinosus</i> , Austin	-	-	x										
" <i>olla</i> , M'Coy	-	-	x										
" <i>Parkinsoni</i> , Kon.	-	-	x										
" <i>polydactylus</i> , Mill.	-	-	x										
" <i>triacontadactylus</i> , Mill.	-	-	x										
" sp.	-	-	x						x				

Fossils.	Derbyshire.	Castleton.	Chrono Hill.	Pack Hill.	Longnor.	Pilbury.	Alstonfield.	Dovedale.	Criceth.	Cromford.	Matlock.	Bakewell.	Ashford.
<i>Archæocidaris Glabrispina</i> , Phill.	x	x		x	x		x						
" <i>Urci</i> , Fien.	x	x											
" <i>vetusta</i> , Phill.	x	x											
" <i>sp.</i>	x	x			x								
<i>Codonaster acutus</i> , M'Coy	x	x											
" <i>trilobatus</i> , M'Coy	x	x										x	x
<i>Cupressocrinus ? calyx</i> , M'Coy	x	x											
" <i>? impressus</i> , M'Coy	x	x											
<i>Cyathocrinus mammillaris</i> , Phill.	x	x											
<i>Pentremiles campanulatus</i> , M'Coy	x	x											
" <i>Derbiensis</i> , Sby.	x	x											
" <i>orbicularis</i> , Sby.	x	x											
" <i>ovalis</i> , Goldf.	x	x											
<i>Platyocrinus ellipticus</i> , Phill.	x	x											
" <i>laciniaius</i> , Phill.	x	x											
" <i>laevis</i> , Mill.	x	x											
" <i>vesiculosus</i> , M'Coy	x	x											
<i>Poteriocrinus granulosis</i> , Phill.	x	x											
" <i>nuciformis</i> , M'Coy	x	x											
<i>Rhodocrinus ? sp.</i>	x	x						x					
Province II.—ARTICULATA.													
Class—CRUSTACEA.													
<i>Bevrichia</i> , sp.	x	x		x	x								
<i>Brachymetopus Ouatricus</i> , Vern.	x	x			x		x	x					
<i>Cyprella chrysalidea</i> , D'Kon	x	x			x								
<i>Cythere</i> , sp.	x	x										x	
<i>Cypridina primæva</i> , M'Coy	x	x		x	x								
<i>Dithyrocaris lateralis</i> , M'Coy	x	x											
<i>Eutomoconchus Scouteri</i> , M'Coy	x	x		x	x								
<i>Griſſithides globiceps</i> , Post.	x	x			x								
" <i>longiceps</i> , Port.	x	x										x	x
" <i>meso-tuberculatus</i> , M'Coy	x	x											
" <i>sp.</i>	x	x			x								
<i>Phillipsia Brongniartii</i> , Fischer	x	x											
" <i>Derbiensis</i> , Martin	x	x		x	x								
" <i>pustulata</i> , Schloth.	x	x		x	x							x	
" <i>seminifera</i> , Phill.	x	x		x	x		x					x	
Sub-Kingdom—MOLLUSCA.													
Province I.—MOLLUSCOIDA.													
Class I.—POLYZOA.													
<i>Fenestella carinata</i> , M'Coy	x	x											
" <i>flabellata</i> , Phill.	x	x											
" <i>formosa</i> , M'Coy	x	x											
" <i>membraacea</i> , Phill.	x	x		x	x	x						x	
" <i>plebeia</i> , M'Coy	x	x											
<i>Glaucanome gracilis</i> , M'Coy	x	x		x	x	x							
" <i>pulcherrima</i> , M'Coy	x	x			x								
<i>Demitrypa (Fenestella) Hibernica</i> , M'Coy	x	x					x	x					
<i>Polypora dendroides</i> , M'Coy	x	x											
" <i>polyporata</i> , Phill.	x	x						x					
" <i>verrucosa</i> , M'Coy	x	x											
<i>Ptylopora fluviiformis</i> , Phill.	x	x											
Class II.—BRACHIOPODA.													
<i>Athyris ambigua</i> , Sby.	x	x										x	
" <i>expansa</i> , Phill.	x	x											
" <i>globularis</i> , Phill.	x	x				x							
" <i>lamellosa</i> , L'Eveille	x	x					x	x					
" <i>planosulcata</i> , Phill.	x	x	x			x							
" <i>Royssii</i> , L'Eveille	x	x											
" <i>subtilita</i> , Hall	x	x		x				x					
" <i>squamigera</i> , Kon.	x	x											
<i>Camarophoria crumena</i> , Mart.	x	x						x					
" <i>globulina</i> , Phill.	x	x			x								
" <i>? laticliva</i> , M'Coy	x	x											
<i>Choncles comoides</i> , Sby.	x	x											
" (<i>Leptæna</i>) <i>gibberula</i> , M'Coy	x	x											
" <i>Hardensis</i> , Phill. (<i>submarina</i> , M'Coy)	x	x											

FOSSILS.	Derbyshire.	Castleton.	Chromes Hill.	Park Hill.	Longnor.	Pilshury.	Alstonfield.	Dovedale.	Orich.	Cromford.	Matlock.	Bakewell.	Ashford.
<i>Terebratula hastata</i> , Sby.	x			x	x								
" <i>var. ficus</i> , M'Coy	x			x									
" <i>sacculus</i> , Martin	x			x		x					x		
" <i>vesicularis</i> , Kon.	x				x	x	x						
Province III.—													
LAMELLIBRANCHIATA.													
Class—CONCHIFERA.													
Order—MONOMYARIA.													
<i>Anomia</i> , sp.	x				x								
<i>Arca cancellata</i> , Mart.	x			x	x								
" <i>decussata</i> , M'Coy	x					x							
" <i>obtusa</i> , Phill.	x			x	x								
" <i>reticulata</i> , M'Coy	x			x	x								
" <i>semicostata</i> , M'Coy	x			x	x								
" <i>sp.</i>	x							x					
<i>Avicula prisca</i> , M'Coy	x			x	x								
" <i>sp.</i>	x			x	x								
<i>Aviculopecten cælatus</i> , M'Coy	x			x	x								
" <i>cognatus</i> , M'Coy	x			x	x								
" <i>concavus</i> , M'Coy	x			x	x								
" <i>depressus</i> , M'Coy	x			x	x								
" <i>ellipticus</i> , Phill.	x			x	x								
" <i>flabellatus</i> , Phill.	x			x	x								
" <i>granosus</i> , Sby.	x			x	x								
" <i>hians</i> , M'Coy	x			x	x								
" <i>intercostatus</i> , M'Coy	x			x	x			x	x				
" <i>macropterus</i> , M'Coy	x			x	x						x		
" <i>planoradiatus</i> , M'Coy	x			x	x								
" <i>Sedgwickii</i> , M'Coy	x							x	x				
" <i>Sowerbyi</i> , M'Coy	x	x			x								
" <i>sublobatus</i> , Phill.	x			x	x								
" <i>tessellatus</i> , M'Coy	x										x		
" <i>sp.</i>	x			x	x								
<i>Gervillia inconspicua</i> , Phill.	x			x	x								
" <i>laminosa</i> , Phill.	x			x	x								
<i>Pinna costata</i> , Phill.	x			x	x	x	x						x
" <i>flabelliformis</i> , Mart.	x			x	x						x	x	
<i>Pteronites angustatus</i> , M'Coy	x			x	x								
Order—DIMYARIA.													
<i>Cardiomorpha lamellosa</i> , Kon.	x			x	x								
" <i>oblonga</i> , Sby.	x			x	x			x					
<i>Conocardium aliformis</i> , Sby.	x			x	x								
" <i>rostratum</i> , Mart.	x			x	x								
<i>Corbula senilis</i> , Phill.	x	x											
<i>Otenodonta palma</i> , Sby.	x			x									
<i>Cypriocardia rhombea</i> , Phill.	x			x				x	x				
<i>Edmondia arcuata</i>	x			x									
" <i>maxima</i>	x			x	x	x							
" <i>squamifera</i>	x			x	x								
" <i>unioniformis</i> , Phill.	x			x	x			x					
<i>Lithodomus dactyloides</i> , M'Coy	x			x				x					
<i>Lucina</i> , sp.	x			x		x							
<i>Modiola elongata</i> ? Phill.	x			x	x								
" <i>lingualis</i> , Phill.	x	x											
<i>Myacites? Omaliana</i> (Pholadomya), Kon.	x												
" <i>Ansticei</i>	x				x								
<i>Myalina lamellosa</i> , Kon.	x				x								
" <i>quadrata</i> , Sby.	x				x								
<i>Pleurophorus costatus</i> , Brown	x				x								
<i>Posidonomya vetusta</i> , Sby.	x				x								
<i>Pullastra bistriata</i> , Postl.	x				x								
<i>Sanguinolites costellatus</i> , M'Coy	x				x			x					
<i>Sanguinolites tricostatus</i> , Portl.	x		x		x				x				
<i>Solenomya</i> , sp.	x												
<i>Venus parallela</i> , Phill.	x					x					x		
Province IV.—ODONTOPHORA.													
Class I.—GASTEROPODA.													
<i>Capulus (Acroculia) neritoides</i> , Phill.	x				x								
" " <i>striatus</i> , Phill.	x				x								
" " <i>vetustus</i> , Sby.	x	x					x						

FOSSILS.	Derbyshire.	Castleton.	Chrome Hill.	Park Hill.	Loughor.	Pilsbury.	Alstonfield.	Dovedale.	Crich.	Gromford.	Matlock.	Bakewell.	Ashford.
<i>Cylindrites (Conus) carbonarius</i> , Kon.	x								x				
<i>Dentalium ingens</i> , Kon.	x			x	x								
<i>Eulina Phillipsiana</i> , Kon.	x			x	x								
" (<i>Turritella</i>) <i>suturalis</i> , Phill.	x											x	
<i>Euomphalus acutus</i> , Sby.	x												
" <i>calyx</i> , Phill.	x												
" <i>Dionysii</i> , Goldf.	x			x	x								
" <i>nodosus</i> , Sby.	x						x						
" <i>tabulatus</i> , Phill.	x							x					
<i>Loxonema ? constricta</i> , Sby.	x			x	x								
" <i>rugifera</i> , Phill.	x							x					
" (<i>Melania</i>) <i>scalaroidea</i> , Phill.	x						x	x					
<i>Macrocheilus acutus</i> , Sby.	x												
" <i>imbricatus</i> , Sby.	x												
" <i>Michotianus</i> , Kon.	x												
" <i>sigmatineus</i> , Phill.	x												
" <i>sp.</i>	x												
<i>Metopoma elliptica</i> , Phill.	x												
" <i>pileus</i> , Phill.	x			x	x								
<i>Murchisonia (Pleurotomaria) biser-</i>	x												
" <i>rata</i> , Phill.	x												
" <i>Humboldtiana</i> , Kon.	x			x	x				x	x			
" <i>serrilimba</i> , Phill.	x								x				
" <i>sp.</i>	x												
<i>Natica elongata</i> , Phill.	x												
" <i>lirata</i> , Phill.	x				x		x				x		
" <i>plicistria</i> , Phill.	x											x	
" <i>variata</i> , Phill.	x											x	
<i>Naticopsis ampliata</i> , Phill.	x												
<i>Patella curvata</i> , Phill.	x			x	x								
" <i>mucronata</i> , Phill.	x				x								
" <i>refrorsa</i> , Phill.	x			x	x								
" <i>sinuosa</i> , Phill.	x				x								
<i>Phanerotinus angustomus</i> , Kon.	x				x								
" <i>eristatus</i> , Sby.	x												
" <i>serpula</i> , Kon.	x							x					
<i>Platyschisma helicoides</i> , Sby.	x			x	x								
" (<i>Pleurotomaria</i>) <i>ovoidea</i>	x												
" <i>Phill.</i>	x												
" <i>tiara</i> , Sby.	x			x	x								
<i>Pleurotomaria callosa</i> , Kon.	x				x								
" <i>carinata</i> , Sby.	x			x	x								
" <i>conica</i> , Phill.	x			x	x								
" <i>depressa</i> , Phill.	x			x	x								
" <i>gemmulifera</i> , Phill.	x				x								
" <i>interstriata</i> , Phill.	x										x	x	
" <i>lenticulata</i> , M'Coy	x			x	x							x	
" <i>striata</i> , Sby.	x												
" <i>tornatilis</i> , Phill.	x				x								
" <i>vittata</i> , Phill.	x										x		
<i>Trochus Jamesii</i>	x				x								
" <i>lepidus</i> , Kon.	x							x					
" <i>Yvanii</i>	x			x	x								
<i>Turbo biseriatis</i> , Phill.	x			x	x								
<i>Bellerophon bicarenus</i> , Lev.	x												
" <i>cornu-arietis</i> , Sby.	x								x	x			
" <i>costatus</i> , Sby.	x												
" <i>hiulcus</i> , Sby.	x							x					
" <i>tenuifascia</i> , Sby.	x												
<i>Porcellia Puzo</i> , Lev.	x			x	x								
" <i>Woodwardii</i> , Sby.	x			x									
Class II.—CEPHALOPODA.													
<i>Cyrtoceras (orthoceras) Gesneri</i> , Mart.	x											x	
" <i>rugosum</i> , Flem.	x											x	
<i>Discites costellatus</i> , M'Coy	x												
" <i>discus</i> , Sby.	x												
" <i>sub-sulcatus</i> , Phill.	x												
" <i>sulcatus</i> , Sby.	x												
" <i>tetragonus</i> , Phill.	x												
<i>Goniatites crenistria</i> , Phill.	x												
" <i>evolutus</i> , Phill.	x												
" <i>expansus</i> , V. Buch.	x												
" <i>Henslowi</i> , Sby.	x			x	x	x							
" <i>serpentinus</i> , Phill.	x						x	x					
" <i>sphaericus</i> , Mart	x												
" <i>striatus</i> , Sby.	x												
" <i>truncatus</i> , Phill.	x												
" <i>vittiger</i> , Phill.	x			x	x								

[illegible]

. INDEX.*

A.		Page		Page
Abbey Brook, section in	-	48	Bar brook, Kinder Grit in	- 86
Abbey Dale, Ganister Coal in	125, 126		— Second Grit in	- 96
Abney Moor, Yoredale Grit on	-	84	— Sections in	- 103
Æolian denudation	-	40	Bar Dyke fault	- 55
Agden Brook	-	4	Bar Tor, Yoredale Grit at	- 84
Agden Fault	- 56, 59, 64, 123		Baslow, Drift near	- 130
Agden reservoir, Second Grit in	-	64	Baslow Bar, Kinder Grit and fault	
Aire R., Drift in valley of	-	131	at	- 87, 88
Alderwasley, Coal on Kinder Grit			Beacon Wood, Fireclays at	- 123
near	-	114	Beeley Brook, Sections in	- 103
— Drift between Belper and	-	130	Beeley Moor, Geology of	- 92, 101
Alport Moor, geology of	-	47	Belper, Coal on top of Kinder Grit	
Ambergate fault	-	114	near	- 114
Amber R.	-	4	— Drift between Alderwasley and	- 130
— sections in	-	106	— Drift west of	- 129
Ankirk Moor, Third Grit on	-	79	— Third, Kinder and Yoredale	
— Shales below Third Grit on	-	80	Grits near	- 111, 114
Anticlinal fault	-	13	Bent Hill, Fault at	- 56, 58, 118
Alport R.	-	4	Beresford Hall, Valley of R. Dove at	- 147
— sections in	-	47	Biddulph Moor, Anticlinal of	- 14
Alport Tower	-	47	Birchall Lodge, Fault at	- 88
Apes Tor, Mountain Limestone			Birchover, Kinder Grit at	- 89
boundary at	-	36	Blacka Hill, Drift at	- 132
— Valley of R. Manifold at	-	148	Blacka Hill faults	- 79, 80
Ashbourn, Drift near	-	129	Black dean Edge and Brook, Coarse	
— Yoredale beds near	-	111	beds in shale below Kinder Grit	
Ashford, Black Marble at, and section of Dirlow Mine	-	26	near	- 43
Ashop Head, fault near	-	42	— Geology of	- 40
Ashop R.	-	4	— Section between and Fair	
Ashopton, Kinder Grit and landslip			brook	- 43
at	-	74	Black hole Clough, Flagstone in	
Ashover valley, geology of	92, 101-103		Kinder Grit at	- 61
Atmospheric denudation	34, 121, 147-149		Black marble at Ashford	- 26
			"Bloody Stone," The	- 130
			Blue John Mine	- 21
			Bole Edge, Third Grit at	- 62
			Bole Hill, Kinder Grit on	- 75
			Bole Hill Plantation, Second Grit at	- 82
			Bolt Edge, fault east of	- 31, 46
			Booth's Edge, fault at	- 79
			— Third Grit on	- 93
			Bore Edge, Kinder Grit on	- 76
			Bosley Minn, Anticlinal of	- 14
			Boulder of Shap Fell Granite at	
			Royston	- 132
			Bow Cross, Fault and Yoredale Grit	
			at	- 88
			Bowden Head, Fault near	- 53
			Bradbourne, Mountain Limestone	
			near	- 111
			Bradfield Basin	- 16, 56-59
			Bradfield Brook	- 4, 123

* Most of the names in this index will be found on the one-inch maps; but some of the Yorkshire localities will be found only on the six-inch maps.

	Page		Page
Bradfield fault - - -	57	Chatsworth Fault, Kinder Grit at -	98, 99
Bradfield reservoir, Second Grit in -	63	Chee Tor - - -	2
— Top of Third Grit in -	62	— Mountain Limestone of -	20
Bradley Rocks - - -	91	— Tunnel, Cutting at mouth of -	19
Bradwell, Mountain Limestone		Chinley Head, Kinder Grit at -	52
boundary at - - -	39	Chrome Hill, Geology of - -	34
Brambley, Fault at - - -	88	Clough Field, Section and fault at -	80
Brassington, Mountain Limestone		Cluther Rocks, Landslips at -	42
boundary at - - -	38	Coal "Clay" - - -	115
Brincliffe Edge Rock - - -	123	— "Coking" - - -	115
Broad Oak Green, Fault at -	125	— Ganister, see "Ganister Coal."	
Broomhead Mill, Old Lead Mine at	118	— on top of Crawshaw Sandstone	66
Brough, Yoredale beds at - -	73	— on top of Rough Rock -	105
Brown Edge, Second Grit of -	81	— on top of Second Grit { 62, 63, 64,	
Brown Knoll, Outlier of Kinder		82, 96	
Grit at - - -	45	— on top of Third Grit -	142
Bull Piece, Ganister Coal at -	120	— — — near Buntingfield	
Burbage Brook, beds between Third		Toll Gate - - -	97
and Kinder Grits in - - -	77, 85	— — — at Chatsworth -	97
— Sections in - - -	103	— — — at Coal Pit House -	78
Burbage Moor, Third Grit on -	77, 79	— — — at Fulwood Mill -	82
Burton Priory, Drift near - -	132	— — — in Oaking Clough -	78
Butterton, Drift near - - -	129	— — — in River Hipper -	97, 105
— Mountain Limestone boundary		— — — at Ringinglowe -	79, 81
at - - -	36	— — — in Rivelin valley -	70
Buxton, Fault east of - - -	20	Coal between Third and Kinder	
— Mountain Limestone boundary		Grits - - -	58, 71
at - - -	33	— on top of Kinder Grit 60, 61, 114, 142	
		— in Mountain Limestone -	25
		Coal-measures, Lower, General de-	
		scription - - -	10
		— Unconformity between and	
		Middle - - -	8, 12
		— Boundary between and Mill-	
		stone grit - - -	8, 12
		— Sandstones, very changeable -	
		11, 118, 119	
		— in Abbey Dale - - -	126
		— between Baslow and Chester-	
		field - - -	127
		— in Bradfield Basin - - -	57
		— in Crawshaw Basin -	60, 64, 67
		— at Dore - - -	126
		— about Ecclesall - - -	124
		— between Oughtibridge and	
		Dore - - -	115-127
		Cock Hill, Kinder Grit at - -	53
		Cockshutts Lane, Oughtibridge,	
		Fireclay at - - -	119
		Combs Dale, Section of Mountain	
		Limestone in - - -	25
		Contortions on eastern side of Penine	
		Chain - - -	49, 51
		Contrast between lie of rocks on	
		opposite sides of Penine Chain -	146
		Coo House, Coal on top of Second	
		Grit near - - -	62
		Corker Walls, fault near - -	64
		Coumbs Wood, Landslips at -	150
		Courses, Kinder Grit at - -	52
		Cowbarn, Yoredale Grit of - -	45
		Crawshaw Basin - - -	16, 59-67
		Crawshaw Sandstone, in Bradfield	
		basin - - -	58
		— Coal on top of - - -	66
		— in Crawshaw basin - - -	66
		— in Gibraltar Rocks - - -	66

C.

Cabin Moss, Section of Yoredale	
Grit near - - -	42
Calamites in Mountain Limestone -	28
Calder, R., Drift in valley of -	131
Caldon, Mountain Limestone bound-	
ary at - - -	35, 36
— Sand and clay near - - -	136
Calton Moor, Mountain Limestone	
boundary on - - -	36
Calver, Fault at - - -	87
— Kinder Grit at - - -	86
Carboniferous Limestone, see "Lime-	
stone."	
Carboniferous System, Subdivisions	
of - - -	8, 11
— Southerly thinning of - - -	143
Carlton, Drift near - - -	132
Carl Work, The - - -	79
Carsington, Mountain Limestone	
boundary at - - -	38
Carter Stones Ridge, Escarpment of	
Kinder Grit on - - -	60
Castle Hill, Bradfield - - -	58
Castleton, Blue John Mine at -	21
— Mountain Limestone boundary	
at - - -	39
Cattis Side Quarry - - -	76
Chapel en le Frith, Brooks between	
Glossop and - - -	148
— Fault north of - - -	53
— Yoredale Grit near - - -	45
Chatsworth Fault - - -	89, 98, 99
— Geology of country east of -	91
— Third Grit Coal near - - -	97

	Page
Crawshaw Sandstone, possible equivalent of near Oughtibridge	116
Cressbrook Tunnel, Mountain Limestone at	19
Crich Hill	92, 107
— Drift near	130
— Southerly fault	106
— Westerly fault	107
Cromford, Mountain Limestone Boundary at	38
Crooked Clough, Section in	54
Crook Hill, Outlier of Kinder Grit on	45
Crow Chine, Joints and Third Grit on	77
Crowdecote, Faulted Mountain Limestone boundary at	34
Crowden Clough, Scenery of	40
— Section in	44
Crow Tor, Landslip at	74
Cuckoo Stone Dale Brook, Sections in	197
— Farm, Fault near	104
Curbar Bar, Fault at	94
Current-bedding	146

D.

Dakin, R., Drift in valley of	130
Dale End, Limestone boundary at	38
Dale Wood, " "	87
Darley Dale Stone	99, 100, 106, 114
Darley Flash, Upper boundary of Third Grit at	97
Darley Moor, Geology of	92, 101
— Section of Mountain Limestone near	28
"Day Stones"	77, 93
Deep dale, Mountain Limestone boundary at	36
Deep Grain, Section in	54
Denudation, Æolian	40
— River and Atmospheric	{ 34, 121, 147-149
— in Yeld Wood	88
Derwent Edge, Escarpment of Kinder Grit on	60
— Flint Implement found on	136
Derwent Hall, Fault at	49, 59
Derwent Moors, Geology of	47
Derwent River, course of	4
Derwent River, Drift in valley of	130, 131
— Gravels of	136
— Origin of valley of	29, 147, 148
— Sections and Contortions in	48
Dicklant, Fault near	101
Dirtlow Mine	26
Dog Rock, Kinder Grit at	53
Dolomite near Wirksworth	30
Don River	4
Dore Coal Pits	126
Doveholes, Elephant bones at	134
— Fault in tunnel at	31
— Section of Mountain Limestone at	22
Doveholes Brook, Junction of Mountain Limestone and Yoredale Rocks in	21

	Page
Dove River, Course of	4
— Course in Limestone	147
Dowel, Mountain Limestone boundary at	34
Drainage	4
Drift, Came from the north-west	133
— General distribution of	128, 133
— In valley of the Aire	131
— In valley of the Calder	131
— In valleys of Wye and Derwent	180, 181
— In gaps through Penine Chain	131, 132
— On east of Penine Chain	132, 133
— West and South of Penine Chain	129
Duffield, Yoredale Grit, near	138
Dunge Wood, Yoredale Beds at	73, 84
Dungworth Coal Pits	122
— Fault	59, 67

E.

Ebbing and flowing Well	46
Ecclesall Coal Pits	124
Ecton Hill, Mountain Limestone, boundary at	36
Edale, Geology of	49, 50
— River Gravels in	51
Edale Head, Weathered Rocks near	40
Edgefield, Fault near	64
Edleston Wood, Fault in	106
Elephant bones	134
Elton, Drift near	130
Emlin Clough, Third Grit in	61
Emlin Hill, Third Grit on	62
Encrusting Spring near Kinder Scout	44
Etherow River	4
Ewden Brook	4
Eyam, Mine near	22
Eyam Moor, Kinder Grit on	84

F.

Fairbrook Clough, Scenery of	40
— Section in	42
— Section between Blackdean Clough and	43
Fairbrook Naze, Kinder Grit at	40
Fallenge Brook, Sections in	103, 104
Fanny Bentley, Yoredale beds near	111
Far fork Grain, Section in	54
Faults, Agden	56, 59, 64, 123
— Ambergate	114
— Bar Dyke	56
— Bradfield	57
— Chapel	53
— Chatsworth	89, 98, 99
— Don valley	116
— Dungworth	59, 71
— Easterly Blacka Hill	79, 80
— Fulwood	80
— Hucklow Edge	84, 93
— Leam	85
— Moscar	59

	Page		Page
Little Rowsley, Outlier of Kinder Grit near - - -	99	Millstone Grit, General description of 8, 140	
Load brook, Fireclay and Rough Rock at - - -	66	— On opposite sides of Penine Chain - - -	143
Lodes, Poor in lower limestones -	109	— Physical features of - - -	3, 62
Longshaw Lodge, Rough Rock and Second Grit at - - -	94	— Upper surface of beds water-worn - - -	10, 61, 142
Longstone Station, Drift near - -	130	Mitchell Field, Kinder Grit and fault at - - -	76
Lords Seat, Second Grit on - - -	81	Moletrap Mine - - -	100
— Yoredale Grit on - - -	45	Monsal Dale, scenery of - - -	2
Lose Hill, Yoredale Grit on - - -	51	— Drift in - - -	130
Low Bradfield, Rough Rock at - -	67	— Tunnel, Section in - - -	18
Lower Shelf, Section in - - -	54	Moor Edge Plantation, Mountain Limestone boundary at - - -	38
Lower Coal-measures, see "Coal-measures."		Moor Hall Bridge, Old Lead mine near - - -	118
Loxley Edge, Landslips on - - -	121	Morwood, Rough Rock at - - -	66
Loxley River - - -	4	Moscar, Second Grit at - - -	62
Ludwell, Mountain Limestone boundary at - - -	35	Moscar fault - - -	59, 67, 68
Lumley Lodge, Second Grit at - -	81	Moscar Plantation, Coal and fireclay at - - -	62
		Mountain Limestone, see "Limestone."	
M.		Mytham Bridge, Yoredale Sandstones at - - -	3
Mag Clough, Fault in - - -	85		
— Yoredale beds in - - -	86	N.	
Mainstone, Kinder Grit at - - -	52	Narrow Dale, Mountain Limestone boundary at - - -	35
— Tilestone at - - -	53	Nether Red Brook, Section in - -	42
Mam Tor - - -	51, 149	Noe, R. - - -	4
Manifold River, Course in Limestone	147	— Sections in - - -	73
Manners Wood, Yoredale Grit at -	88	— Gravel of - - -	135, 136
Mapping, detailed geological necessary - - -	137	Notton, Drift near - - -	132
Matlock, Section of Mountain Limestone at - - -	28		
— Bank, Yoredale Grit at - - -	100	O.	
— Little - - -	122	Oaker, Mountain Limestone near -	91
Masborough, Drift at - - -	132	Oaker Hill, Geology of - - -	91
Mermaid's Pool, Encrusting spring near - - -	44	Oaking Bank, Third Grit on - - -	58
Middleton by Wirksworth, Limestone boundary at - - -	38	Oaking Clough, Fault in - - -	59, 78
Milken Lane, Millstone Grit in - -	102	Odin lode - - -	46
Millclose Mine - - -	26	Odin mine - - -	31
Mill Hill, Kinder Grit on - - -	45	Old Pit Plantation, Fault at - -	52
Mineral veins, poor in lower limestones - - -	109	Ollerbrook Clough, Section in - -	44
Mines, Blue John - - -	21	Onesacre, Coal near - - -	120
— Broomhead Mill - - -	118	Onesmoor, Geology of - - -	56
— Crich Hill - - -	109	Onesmoor fault - - -	56, 118
— Dirlow - - -	26	Orgreave, Drift near - - -	132
— Great Hucklow - - -	24	Oughtibridge, Fault in Coumes valley near - - -	118
— Gregory - - -	102	— Fireclay in Cockshutt's Lane -	119
— High Rake - - -	22	Outliers, basin-shaped lie of bedsi n	149
— Ladywash - - -	22, 84, 86	Over Hall Field, Yoredale limestones at - - -	112
— Millclose - - -	26	Over Owlter Tor, Third Grit on - -	93
— Moletrap - - -	100	Over Town, Outlier of Third Grit near - - -	102
— Moor Hall Bridge - - -	118		
— Odin - - -	31	P.	
— Tansley Moor - - -	102	Park Hill, Geology of - - -	34
— Tideswell Moor - - -	23	Parson's House, Third Grit and Joints near - - -	79
Millers Dale, Scenery and geology of - - -	2, 19		
Millstones - - -	77, 79, 93		
Millstone Grit, Boundary between and Lower Coal Measures -	8, 12		
— Formation of - - -	10, 141		

	Page
Parwich Leys, Mountain Limestone	
boundary at - - -	38
Peak, Euerusting spring on the - -	44
Geology of the - - -	40-45
preserved by basin-shaped lie	
of beds - - -	149
Landslips on the - - -	42, 44, 149
Weathered rocks on the - - -	40
Peaks Hole Water, Gravel of - -	136
Peak Tor, Geology of - - -	91
Drift near - - -	130
Peck Hall, Rough Rock at - - -	58
Pecks, Limestone boundary at The	33
Penine Chain, Contortions on east-	
ern side of the - - -	49, 51
Dip on opposite sides of the - 2,	128
Distribution of Drift round the	128
Drift east of the - - -	132, 133
Drift west and south of - - -	129-131
Faults on western side of the - 46,	47
General description of - - -	1, 128
General structure of country	
east of - - -	16
west of - - -	13-15
Lie of rocks on opposite sides	
of the - - -	146
Pepper Inn, Mountain Limestone	
boundary at - - -	36
Perryfoot, Mountain Limestone	
boundary at - - -	31
Physical features of country de-	
scribed - - -	1-3, 128
Pig Tor-Tunnel, Mountain Lime-	
stone at - - -	20
Platts, Fireclay near - - -	67
Porter Brook - - -	4

R.

Raddle Pit Rushes, Coal on top of	
Kinder Grit at - - -	61
Ran Moor, Section and fault at - -	80
Rattlers Coal - - -	125
Raven Tor, Yoredale Grit at - -	102
Rediker Brook, Sections in - - -	80
Red Rock Fault - - -	14
Renishaw, Drift near - - -	133
Riber Hill, Drift on - - -	130
Yoredale Grit on - - -	100
Rickett Field, Fault at - - -	59
Ringinglowe, Colliery at - - -	81
Second Grit at - - -	82
Rivelin brook - - -	4
Rivelin northerly fault - - -	72
southerly fault - - -	71
valley, Geology of - - -	67-72
River denudation - - -	34, 147, 148
River gravels, of the Derwent - -	136
in Edale - - -	51
near Haddon Hall - - -	130
of Peaks Hole Water - - -	136
of River Nee - - -	135
Roach Wood, Kinder Grit at - - -	101
Robin Hood Inn, Coal and Second	
Grit at - - -	96
Ronksley Moor, Geology of - - -	47

	Page
Rood Hill Basin - - -	16, 72-83
Rotherham, Drift near - - -	132
Rough Rock, in Ashover valley - -	102
in Bradfield Basin - - -	57, 58
in Crawshaw Basin - - -	60, 66
near Crich - - -	107, 110
between Fox House and Bram-	
ley Fall Quarry - - -	94, 95
General description of - - -	9, 140
Round Hill, Shales below Kinder	
Grit at - - -	54
Round Wood, Kinder Grit at - - -	106
Rowel Bridge, Fault near - - -	122
Rowsley, Fault north of - - -	99, 104
Rowter Rocks - - -	89
Roych Tor, Yoredale Grit of - - -	46
Royds Clough, Rough Rock, Second	
Grit, and Fireclay at - - -	67
Royston, Drift near - - -	132
Rudyard basin - - -	13
Rushup Edge, Fault below - - -	46
Yoredale Grit of - - -	45

S.

Sallow Clough, Fault in - - -	52
Sands and Clays of the Weaver	
Hills - - -	136
Sandyford Brook, Second Grit in - -	95
Sandy Gate, Second Grit at - - -	82
Second Grit in Ashover valley - -	102
in Bradfield basin - - -	57, 58
in Crawshaw basin - - -	60, 62-64
between Fox House and Swine	
Sty - - -	94
General description of - - -	9, 140
in Rood Hill Basin - - -	81, 82
between Swine Sty and Stone	
Edge fault - - -	96, 105
Shales below Kinder Grit, below	
northern escarpment of Kinder	
Grit - - -	54
Coarse Grits in - - -	43
General description of - - -	6
round The Peak - - -	42-44
Shale Grit, Farey on - - -	6 (note), 100
Shap Fell Granite, Boulder of near	
Royston - - -	132, 134
Shatton, Fault near - - -	78
Sheaf, R. - - -	4
Sheffield, Drift near - - -	132
origin of name - - -	4
Shelf Brook, Section in - - -	54
Shelf Moor, Weathered rocks on - -	53
Shire Hall, Kinder Grit at - - -	53
Sicklehome, Fault at - - -	73
Sir William Hill, Fault near - - -	84
Slack Hall, Yoredale Grit near - -	45
Small Dale, Fault at - - -	73
Smallfield, Agden fault at - - -	57
Snitterton, Section of Mountain	
Limestone near - - -	28
Southerly Crich Fault - - -	106
thinning of Carboniferous	
Rocks - - -	143
Rivelin Fault - - -	71

	Page		Page
South Head, Kinder Grit of	52	Thornseat Hill, Third Grit at	62
Sparrow Pit, Mountain Limestone boundary at	31	Thorns Wood, Mountain Limestone boundary at	36
Stainmoor Pass, a passage for Drift	131	Thorpe Cloud, ditto	38
Stanage Edge, Fault at southern end of	79	Tideswell Moor, Mines on	23
— Joints on	78, 143	Tilestones, at Mainstones	53
— Third Grit on	77	— in shale between Kinder Grits	57
Stanage Pole, Second Grit at	81	— in Yoredale Grit	48
Stanciliffe Hall, Landslip at	100	Tissington, Drift near	129
— Kinder Grit at	99	— Mountain Limestone boundary at	38
Stand Hills, Third Grit at	82	Toadstone at Ashover	103
Standlow, Faults at	112	— on Crich Hill	107, 109
Stannington Wood Coal Pits	121	— General description of	5, 30, 137
Stanton, Drift near	130	— at Great Hucklow	24
Stanton Moor, Geology of	89-91	— Hopkins on	5
Steiner Clough, Shales below Kinder Grit in	54	— at Hopton	30
Stoke Flats, Chasm on	93	— Junction of limestone and	19, 20, 22
Stoke Moor, Kinder Grit on	86	— near Kniveton Wood	111
Stoke-on-Trent, Drift near	129	— at Matlock	28
Stoke Sough	22	— at Mill Close mine	26
Stone Edge Fault	96, 97, 101	— probable vent of	23
Stone Hay, Second Grit at	96	— at Wirksworth	30
Stoney Middleton, Coal in Mountain Limestone near	25	— in Yoredale beds	112
— fault	87, 93	Treak Cliff, Mountain Limestone boundary at	31, 39
— Mountain Limestone boundary at	38	Trinity Chapel Fault	101, 102, 110
Stoop, Mountain Limestone boundary near	33	Turnditch, Yoredale Limestones south of	112
Strines Dyke, Sections in	61		
— Physical geology of	63, 140		
Strines Edge, Fault at south end of	59		
— Third Grit on	62		
Stubbing, Ganister Coal at	120		
Stump John, Anticlinal south of	68		
Sugworth, Second Grit and Coal at	63		
Surrey Arms, Second Grit near	62		
Swallow Holes along faults	33, 35, 36		
— along Limestone boundary	31		
Swine Sty, Second Grit near	95		
Sydnope Brook, Sections in	104		
Sydnope House, Section near	98		
T.			
Tansley Moor, Geology of	92, 101		
— Mines on	102		
Third Grit in Ashover valley	101		
— near Belper	111		
— in Bradfield basin	57, 58		
— between Chatsworth and Trinity Chapel	97		
— in Crawshaw basin	60, 62		
— between Fox House and Chatsworth	93		
— General description of	8, 140		
— Good sheep pasture on	93		
— at Harecliff Rocher	58		
— in Rivelin valley	67, 71		
— in Rood Hill basin	77-80		
— at Thornseat Hill	62		
— Upper boundary of in Bradfield reservoir	62		
— north-east of Watstandwell Bridge	106		
		U.	
		Ughill fault	64
		Upper Padley, Fault near	93
		Upper Red Brook, Section in	42
		Upper Reeves Low, Fault at	74, 77
		V.	
		Veins mineral, poor in lower limestone	109
		W.	
		Wadsley, Ganister Coal near	121
		Walker's House, Coal on Second Grit near	63
		Walton Hotel, Mountain Limestone boundary near	38
		Warslow, Mountain Limestone boundary near	36
		Warslow Hall, Section near	36
		Waterfalls at base of sandstone beds	3, 103, 105
		Waterhouses, Elephant bones at	134
		— Mountain Limestone boundary at	36
		Watershed, Line of main	4
		Watstandwell Bridge, Kinder and Third Grits at	106
		Weathered Rocks, on Derwent Edge	60
		— on The Peak	40
		— on Shelf Moor	53
		— near Stanton	89
		Weaver Hills, Sands and Clays of the	124

	Page		Page
Weaver Hills, Mountain Limestone		Yoredale Grit, below northern es-	
boundary at the -	13, 36	carpment of Kinder Grit -	55
Westend Head, Yoredale Grit near	54	near Belper -	111, 114
Western Crich Fault -	107	near Bow Cross -	87
Westfield, Rough Rock at -	66	Building stone in -	88
Westnab, Rough Rock at -	58	Changeableness of subdivisions	
Wetton Hill, Mountain Limestone		of the -	39, 43
boundary at -	36	Conglomerates in the -	42, 48
Whirlow Bridge, Second Grit at -	82	in Derwent R. -	48
White Edge Lodge, Second Grit		near Duffield -	138
quarried at -	95	east of Eyam and Stoney	
Whiteley Wood School, Section and		Middleton -	84
fault at -	80	General description of the -	6, 138
White Tor, Yoredale Grit at	100	at Kirk Ireton -	112
Whitfield, Kinder Grit at -	52	in Lady Wash Mine -	84
Wigin Dale, Mountain Limestone		on Lords Seat -	51
boundary at -	38	on Lose Hill -	51
Wigley Farm, Coal on top of		on Oaker Hill -	91
Second Grit at -	82	in Rood Hill basin -	73
Williams Clough, Fault in -	46	between Rowsley and Crich 100, 105	
Windy Knoll, Mountain Limestone		Yoredale Grit, on Stanton Moor -	91
boundary at -	31	Subdivision into Upper and	
Win Hill, Kinder Grit on -	45	Lower -	42, 45, 84
Wirksworth, Drift near -	129	round The Peak -	45-49
Mountain Limestone boundary		Yoredale lowest group, at Alport	
near -	38	Bridge -	48
Mountain Limestone, Dolo-		north of Ashbourn -	111
mite, and Toadstone at -	30	in Ashover valley -	102
Wood Brook, Sections in -	104	between Bakewell and Rowsley	87
Wooden Pole, Fault near -	95	near Belper -	111
Woodlands, Geology of The -	47	in Castleton valley -	7, 51
Woodseats, Second Grit at -	63	Chert in the -	112
Worrall, Fireclay at -	120	in Edale -	51
Wye, R., Course of -	4	General description of the -	7, 140
Drift in valley of -	130, 131	near Hassop -	87
Origin of valley of -	148	near Hathersage -	73
Y.		Limestones of, unusually thick	112
Yates Clough, Conglomerates in		Toadstone in the -	112
Yoredale Grit in -	42	near Wirksworth -	112
Yeld Wood, Atmospheric denuda-		Yoredale Sandstones, at Alport	
tion and Kinder Grit in -	88	Bridge -	48
Yews, Bore Hole near The -	120	in Edale -	51
Yoredale beds, Comparative Sections		General description of the -	7, 138
of -	139	in Highlow Brook -	84
General description of -	5-7	at Kirk Langley -	113
Yoredale Grit on Abney Moor -	84	on Mam Tor -	51
in Alport R. -	47, 48	on Pendle Hill -	140
in Ashover valley -	102	in Rood Hill basin -	73
on Back Tor -	51	in Wensleydale -	140
near Bakewell -	88	Yorkshire Bridge, Sections near	49
		Youlgreave, Drift near -	130

12

the 1990s, the number of people in the world who are under 15 years of age is expected to increase by 1.5 billion (United Nations 1994).

There is a growing awareness of the need to address the needs of children in the 1990s. The United Nations has developed the Convention on the Rights of the Child (1989) which sets out the rights of children and the responsibilities of governments. The Convention has been ratified by 112 countries, including the United Kingdom. The Convention states that children have the right to be heard in decisions that affect them and that governments should ensure that children's views are taken into account in all decisions that affect them.

The Convention also states that children have the right to a standard of living adequate for their health, development and well-being. This includes the right to adequate food, clothing, housing and health care. The Convention also states that children have the right to education and to participate in cultural life and leisure activities.

The Convention also states that children have the right to be protected from all forms of neglect, abuse and exploitation. This includes the right to be protected from physical and sexual abuse, from being used in armed conflict and from being used in the workplace.

The Convention also states that children have the right to be protected from all forms of discrimination. This includes the right to be protected from discrimination on the basis of race, ethnicity, religion, sex and social class.

The Convention also states that children have the right to be protected from all forms of violence. This includes the right to be protected from physical and sexual violence, from being used in armed conflict and from being used in the workplace.

The Convention also states that children have the right to be protected from all forms of exploitation. This includes the right to be protected from being used in the workplace and from being used in the armed forces.

The Convention also states that children have the right to be protected from all forms of neglect. This includes the right to be protected from being abandoned and from being used in the workplace.

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